THE

AMERICAN

JOURNAL OF PSYCHOLOGY

VOL. X.

THE MIGRATORY IMPULSE VS. LOVE OF HOME.

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INTRODUCTION.

The migration of animals and peoples, the wandering of tribes and roving impulse of the individual, have been woven into legends and myths, carved upon stone and written upon parchment, ever since the advent of human thought.

The predatory advance of the locust,[1] the measured flight of certain butterflies,[2] the martial like procession of caterpillars and ants [3] have long inspired wonder, superstition and thought, "The [4]human race is more concerned in the movements and migrations of fish than in the question of their permanent abode." To the ancients the flight of birds was a token of prosperity or adversity according to the direction of the flight. If an eagle flew over from left to right or from right to left, the former was regarded a good omen, the latter an evil one. Among the hieroglyphs on the monuments of the Pharoah's are represented wild-goose fowling as these birds were making their annual migrations through the Nile Valley. The [5]prophet Jeremiah in rebuking the seared consciences of the Jews, spoke in this fashion : Yea, the stork in the heavens knoweth her appointed times and the turtle and the crane and the swallow observe the time of their coming ; but my people know not the judgment of the Lord.

The folk-lore of many tribes, the beginnings of many great

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[1] Figuier : The Insect World. Page 302.
[2] Couch : Illustrations of Instinct, pp. 145-150.
[3] Huber : Ants.
[4] Baird, Spencer F : U. S. Fish Com. Report, 1886, p. 47.
[5] Jeremiah 8 : 7.

nations in addition to historical facts, consist of migratory legends and myths of wandering.

The tradition of the Hebrew, which tells of their migration into Palestine from the countries across the Euphrates, is substantiated by their tribal name, *ibri, i. e.*, one who has crossed. The Doric traditions of an imigration from Thrace and Macedonia through Epirus into Greece is confirmed by linguistic facts. The legendary account of the migration of Cadmus, leading to the foundation of Thebes, the checkered and wandering life of Æneas, previous to his marriage and settling in Italy, the adventurous and romantic journey of Ulysses from Troy to Ithaca have given to literature its classic wanderers for all time.

All tribes of the Maskoki stock of Indians,[1] likewise the Washoe around Carson City and Tinne-Appache of New Mexico possess migration legends intermingled with myths and mythic ideas. Many of the [2] Polynesian tribes have similar traditions.

In recent times Germany and Austro-Hungary have established stations for observing bird migration. Scientists of Great Britain utilize part of her lighthouse service for collecting data on bird movements. In our own country many men of the weather bureau service have divided their time between observing weather phenomena and collecting data on the flight of birds.

Several attempts[3] have been made by naturalists and anthropologists[4] to trace out the migrations.[5] of man from his [6] primitive home until he had peopled the whole earth. Journalism[7] has recently given some space to accounts of roving and tramp[8] life. Within the past two years some systematic study has been devoted to Truancy,[9] chiefly[10] along statistical, sociological and anthropometrieal lines.

The writer was brought face to face with this instinct while in conversation with a few of the beneficiaries of the associated

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[1] Gatschet, A. S.: A Migratory Legend of the Creeks, p. 218, Phil. 1884.

[2] Sittig, Otto: Compulsory Migrations in the Pacific Ocean. Smith. Report, 1895, pp. 519-35.

[3] Sittig Otto: *loc. cit.*

[4] Mason, O. F.: Amer. Anthro., Vol. II, No. 3, 1894, Migration and the Food Quest.

[5] Brinton, G. D.: Races and People.

[6] Müller, Friedrich: Allgemeine Ethnographie.

[7] Noble, C. W.: Border Land of Trampdom. Pop Sci. Month, Vol. L, p. 252.

[8] Flynt, Josiah: Century Vols. XXIV and XXV, 1893. Same author in Atlantic Month. Vol. LXXVII, p. 88.

[9] Fifty-ninth Annual Report, Board of Ed. of Mass.

[10] *Pedagogical Seminary*, Vol. V, No. 3, 1898.

charities of Boston. A description of one will suffice, for in respect to this trait they differed but little.

A young man of American parentage who had just recovered from a spell of sickness in a Boston hospital presented himself to the manly department of the association asking for money to purchase a ticket to Springfield, Mass. He seemed very anxious to get work again and had a strong hope that he could do so were he only in Springfield. He produced evidence showing that he was a skilled workman and had given satisfaction to his employers. It was found that he had come from New York and to New York he had gone from Springfield, Mass., to which latter place he now longed to return, though he had neither home nor relatives in the place. He had paid his respects to each of these four cities within five months. No particular reason could he assign for leaving any one place, except that he thought a change was good for him. After remaining a certain length of time in a place, familiar objects and places became distasteful, even the odors of the shop would haunt him and at times the very sight of shop comrades would appear repulsive. Peace of mind came only by breaking away and entering into the life of a new place. He recognized painfully that it was not the way to provide for a rainy day nor to become a practical citizen.

Says Flynt : "[1] I have known men on the road who were tramping purely and simply because they loved to tramp. They had no appetite for liquor or tobacco, so far as I could find, also were quite out of touch with criminals and their habits; but somehow or other they could not conquer that passion for roving. In a way this type of vagabond is the most pitiful that I have ever known ; and yet is the truest type of the genuine voluntary vagrant. . . . . To reform him it is necessary to kill his personality, to take away his ambition and this is a task almost superhuman. Even when he is reformed he is a most cast down person."

"Ten [2] years ago four young men of this city took a pedes-

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[1] Flynt, Josiah : Century, Oct., 1885, p. 941.
[2] One of over 500 cases taken from Rubrics II and IV. See Syllabus below.

TOPICAL SYLLABI FOR CHILD STUDY.

(Series for Academic Year 1896-7).

III. MIGRATIONS, TRAMPS, TRUANCY, RUNNING AWAY, ETC., vs. LOVE OF HOME.

I. Consider whether you know any small child with a propensity to run away ; and if so describe the circumstances—why, when, where it went, whether alone, and planned, or impulsively, and all the details and incidents of each case ; its adventures, how it was found,

trian trip to the Delaware Water Gap. They were all of good families and of excellent habits. On returning home three of them resumed their every-day life, but F., who was about twenty years old, after staying home several days disappeared and did not return for several weeks. When he came back he told the alarmed family that he had been on another tramp. Since that time he has been all over the United States working only when he could not obtain food or lodging otherwise. He returns home at intervals but stays only for a few days, and does not appear to have formed any bad habits, but cannot overcome the desire to wander. He still seems to have affection for those at home, yet cannot content himself to stay with them. As none of his relatives have led adventurous lives, his parents cannot account for his strange behavior.''

whether deterred later by its experiences, at what age this disposition appeared and when it ceased and why.

II.   Describe the same with boys and girls in their teens, who leave home for love of adventure, anger, impatient of restraint, to start life for self, etc., definite plans or none.   Give every incident of cause, experiences, hardships, etc., you can find out.

III.   Describe any case of truancy from school or church, its motives, traits of the child, mode of concealment.

IV.   In your own experience what are the charms of travel in order of interest, whether of a trip to Europe, a ride or bicycle journey, a lonely walk of a day's duration, globe-trotting, etc.   Have you ever left home aimlessly, and before leaving had you lost property and friends or been injured in feelings ?   Have you been tempted to ''disappear,'' and what reasons, or left home to ''do the world '' or ''paint the town ?''   Have you ever suffered intense hunger, and if so describe your feelings.

V.   What do you know of tramps ? have you ever interviewed one, or can you do so ? what have you ever read or heard of them ?

VI.   Do you know people who move frequently, and if so, state why, where, how often and all you know of them.

VII.   Do you know anything of gypsies or can you find out any. thing ?

VIII.   Do you know an inveterate visitor, call-maker, gad-about person, who must be always on the street or on the go ?   If so describe them carefully, and see if you can account for it ;   or of boys with a passion to start out for themselves exceptionally early in life.

IX.   The same of any one who loves home so intensely that he or she will only very reluctantly go away for, or be away nights.

X.   What are the elements in your own love of home in order—as love of father, mother, brother, sister, the house, hills, trees, and natural scenery, familiar ways of life, etc.

XI.   Describe any case of homesickness you know of and especially if you have experienced it yourself.

XII.   Describe your own experiences with spring fever, ennui that impelled you to go or be far away, longings in the distance, desire to break away and see the great world and take a part in its actions. Have you ever felt thus concerning a future life as connected with either *religion, love or conflict ?*

In each case specify each of the following points: 1, age ;   2, sex ;

Here, then, is an activity of the soul, woven into legends and folk-lore, is discussed in history and science, and affects profoundly the social and domestic life of a people. An instinct that destroys for the time being even the activities that provide for the immediate wants of life, that drives out considerations for home, relatives and friends, that overpowers the sympathetic, the domestic, the home-making spirit of man, that unfits him for static toil and conditions, and impels him to seek a change, the new, strange and untried.

Modern biology in its interpretation of *form and function* begins its work with the undifferentiated organ or organism in question, and follows it through its phylo-ontogenetic developing paths, both by the methods of experimental morphology and comparative anatomy until present conditions are reached. The verdict of these methods, especially the former, is that the efficient causes in the process are first,[1] "internal causes,

3, nationality; 4, occupation of parents; 5, are one or both living? 6, do they own their homes? 7, is their food and clothes good? 8, toys; 9, books; 10, pin-money; 11, affections; 12, has the child any physical defects? 13, is it oldest, youngest or only child? 14, is it quick-tempered? 15, sensitive; 16, demonstrative; 17, laugh and cry easily; 18, cheerful; 19, active; 20, generous; 21, fond of playmates or reticent and inclined to be alone; 22, does it seek to govern others and does it obey readily? 23, love or shun crowds; 24, or dark; 25, animals; 26, deep water; 27, out of door life, fondness for woods, fields, etc.; 28, does it love music, does it dance? 29, a good color sense, and what are its favorite colors? 30, is it careless or tidy and dressy? 31, has it had pets, is it good to animals? 32, careful of property; 33, and of others' rights; 34, made a collection of things; 35, is it persistent in carrying out tasks? 36, is it inquisitive and talkative? 37, were there ample opportunities for taking exercise, were games and sports encouraged? 38, was there plenty of physical or manual labor at home? 39, must there have been long hours of sedentary work at home and in school? 40, *always specify the season of the year of every incident if possible;* 41, was their immoderate love of sight-seeing, being out evenings, camping out, hunting, excursions, picnics, etc.?

XIII. What have you observed concerning the migrations and the homing instincts of animals, cats, dogs, cows, horses, hens, rabbits, pigeons, fish, ducks, etc., etc.? What have you read, and can you send or refer to any literature or reports of cases? What have you observed of any lower forms of life that move freely at first and then become sessile or fixed as parasites, of nuptual flights of insects?

XIV. What special literature can you refer to on tramps, homesickness, truancy, gypsies or on any other aspect of this topic?

In any case giving the full name of any part of it is optional with the one answering.

Kindly send your answers to

<div align="right">G. STANLEY HALL,
or L. W. KLINE.</div>

CLARK UNIVERSITY,
Worcester, Mass., Oct. 26th, 1896.

[1] Davenport, C. B.: Experimental Morphology, Part I, p. 8.

which include the qualities of the developing protoplasm;"
second, "external causes, which include the chemical and phy-
sical properties of the environment in which the potoplasm is
developing."

The genetic psychologist has taken his cue from the biolo-
gists, and accordingly—after making certain assumptions, a
feature common to all sciences, concerning the relations of
mind [1] and body,[2] heredity and the like, unnecessary to discuss
here—goes back to primitive psychic life, and investigates both
the causes and the processes in its development until it reaches
conditions found in the adult form. The factors believed to be
operative in originating and determining the causes of psychic
differentiation are (1) those inherent in the *principle life* itself;
(2)*cosmic*, including chemical substances, moisture, heat, pres-
sure, light and electricity, and their innumerable combinations
and ever changing relations to each other and to *life;* and
(3) *social*, meaning by the latter all those influences that proceed
from members of the same family, tribe and species, together
with all other species, both plants and animals. Dr. Brinton[3]
writing on the role played by social influences in psychical
differentiation says : "The psychical development of men and
nations finds its chief explanation, less in the natural sur-
roundings, the climate, soil, and water currents, as is taught
by some philosophers, than in their relations and connections
with each other, their friendships, federations and enmities,
their intercourse in commerce, love and war." To present the
point of view of the present investigation, to sensitize our
minds as to the delicacy of the interaction between cosmic
forces and life, and the nature of the latter's response, I pro-
pose to give, very briefly, indeed, the results of some experi-
ments and observations on temperature,[4] one of the most vital
forces operating on organic life.

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[1] "The process of psychical evolution runs parallel with the evolu-
tion of organic life." Paulsen: Introduction to Philosophy, p. 143.

[2] "The key-note of modern biology is evolution; and on the hy-
pothesis of scientific monism here adopted. . . . We are not only
logically justified in extending our comparative psychology so as to
include within its scope the field of zoölogical psychology, but we are
logically bound to regard psychological evolution as strictly co-ordi-
nate with biological evolution." Lloyd Morgan: Introduction to
Comparative Psychology, pp. 36-37.

[3] Brinton, G. D.: *loc. cit.*

[4] It should be remembered that temperature is only one among
many determining developmental factors, and that what is presented
here is merely a type of a large number of studies made on the be-
havior of protoplasm in the presence of chemicals, density of fluid
medium, gravity, electricity and light. Doubtless the most compre-
hensive modern works of experimental morphology are Loeb's Un-
tersuchungen z. Physiologischen Morphologie, d. Thiere, 1892; M.
Verworn's Algemeine Physiologie, 1895; and C. B. Davenport's Ex-
perimental Morphology, 1897.

What quantitative limitations does temperature impose upon life?

The range of life in temperature is less than 100° of the temperature scale. "So[1] delicate is the adjustment between living matter and the conditions by which it is environed that if the mean temperature of the earth were raised or lowered through only a few dozen degrees, the teeming creatures of air, water and land, would cease to exist." Upon this point Professor Shaler[2] observes : "The range of heat which life can sustain may be taken as less than 100°; but in the sun we have a temperature which cannot well be estimated as less than a hundred thousand degrees Fahrenheit, and in the depth of the earth is probably to be measured by tens of thousands of degrees on that scale, while in the realm of ether between the solar and terrestrial spheres there is a degree of cold which is certainly to be reckoned as some hundreds of degrees below zero. Amid these contending extremes of heat and cold life must find its narrow place." If these inconceivably large numbers be expressed in linear terms, we have a line one hundred thousand inches in length, an extension of about one mile and a half, let the space of each inch represent one degree Fahrenheit. On that scale mark off a space of eight feet near one end and this trifling part of the length of the whole line gives us a diagrammatic representation of the ratios between the temperatures of the solar system and those in which organic life can be maintained. This delicate adjustment of life to temperature is clearly expressed by spatial limitations. "It is highly probable that at no time since the beginning of life in the unstable material forms as we know it, has temperature conditions necessary for life existed much over five miles above the level of the sea even at the equator."

Relations of life to temperature considered experimentally. The casual observer knows that fowls droop their wings, that swine hunt the wallow and the ox the shade of the oak in hot weather. Every farmer, gardner and florist knows well that the effectiveness of the hot-bed and green-house in producing vigorous, healthy plants, depends upon a very narrow range of temperature.

The experimental investigations of Velten,[3] Kerner,[4] Mendelssohn,[5] Verworn,[6] Loeb[7] and others show quantitatively the

[1] McGee : Anthropological Society, Washington, D. C., 1894.

[2] Shaler, N. S.: Interpretation of Nature, pp. 67, 68-117.

[3] Velten. Quoted by Davenport: Experimental Morphology, pp. 226-227, 1897.

[4] Kerner : The Natural History of Plants, Vol. I, pt. 2, pp. 557-8. (Tr. by Oliver.)

[5] Mendelssohn : Archiv. fur die ges, Phys., Band 60, 1895.

[6] Verworn : Allgemeine Physiologie.

[7] Loeb: Untersuchungen z. Phys. Morphologie, d. Thiere.

exceeding sensitiveness of protoplasm to temperature. Engle-
mann,[1] Edward,[2] Mendelssohn, Cambell,[3] Davenport, have
demonstrated that in general protoplasm is more responsive
the closer we approach its optimum temperature—a tempera-
ture of about 30°c.

A more direct line of evidence showing the relation of the
activities of protoplasm to temperature is found in the fact that
organisms, in general, absorb more oxygen and excrete more
carbon dioxide the higher the temperature within certain limits.

This has been sufficiently proven by the germination and
growth of seedlings,[4] by the increase of rhythmic movements of
the contractile vacuole of infusoria in rising temperature.[5]
Numerous[6] experiments on air breathing[7] animals confirm the
same general law, and, furthermore, establish a relationship[8]
between the oxygen absorbed and the carbon dioxide given
off. But nowhere do I find experimental evidence on the
quantitative differences between either the absorption of oxygen
or the excretion of carbon dioxide at the optimum of an organ-
ism and at temperatures above and below that point.

I present here in detail a series of experiments carried out
on tadpoles[9] with a view to gain some evidence on this
problem. The first[10] part of the problem was to ascertain

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[1] Englemann, Th. W.: Flimmeruhr u. Flemmermühle Zwei, App.
Z. Register d. Flemmerbewegung. Pflüger Archiv. f. Phys., pp. 501-
502, Vol. XV, 1877. (See Fig. 1 and F. af 6.)

[2] Edward, Chas. L.: Stud. Biol. Lab. Johns Hopkins Univ., Vol. IV,
1888, pp. 19-35.

[3] Campbell: Stud. Biol. Lab. Johns Hopkins Univ., Vol. IV, pp.
123-145.

[4] Vine, S. H.: Physiology of Plants, p. 198. (See table.)

[5] " From all these facts we may conclude that, within certain limits,
an increase of temperature increases metabolism, and a diminution of
temperature diminishes it." Davenport: Experimental Morphology,
p. 225.

[6] Regnault et Reiset: Recherches chimiques sur la respiration des
Animaux des diverses classes. Annales de chemie et Physique, pp.
299 et seq.; 3me Ser; Tome 26, 1849.

[7] Colosanti: Ueber den Einfluss der umgebenden temperatur auf den
Stoff wechsel der Warmblütes Pflüg. Arch., Vol. XIV, pp. 92, 469,
1877.

[8] Page: External Temperature Affecting the Amount of CO_2, etc.,
Jour. of Phys., Vol. II, p. 228, 1879-'80.

[9] I chose this form of animal because it lends itself readily to a vari-
ety of experiment with comparatively simple apparatus, and also on
account of its delicate and ready response to changes of environment.

[10] For this purpose a zinc trough 20cm deep, 16cm wide and 2.3
meters long, supported by a wooden frame, was constructed. To the
bottom of the trough 16cm from one end a tin box 12cm wide, 15cm
long and 6cm deep was soldered. The box received water through a
hole cut in the zinc. Water was conducted to the hole through a
stand pipe soldered to the inside bottom of the trough. The tin box
served two purposes: first, it admitted a direct application of the

whether or not the tadpole will choose voluntarily his optimum.[1]

(1) Sixty-seven tadpoles were placed in the middle of the rectangular trough, the temperature of the water being 4°c throughout. They leisurely distributed themselves equally throughout its whole extent. Heat was now applied to the left end, the right end resting on iced sawdust. When the left end reached 16°c the tadpoles began to congregate in that region, and especially about the standpipe. No one remained very long in any one place, though they did not appear at all uncomfortable. Each movement was attended by a leisurely indifferent motion of the tail, as if the rising temperature was a source of comfort. The temperature at the right end at this moment was 6°c, containing only a few tadpoles which seldom moved. At 20°c the left end was crowded, thus showing that for that temperature they are positive thermotactic. At 24°c the tadpoles showed marked discomfort. The movements were no longer of an indifferent lazy waggle, but were decided and quick, showing that they were beginning to experience uncomfortable quarters. As yet, however, there were no movements in a definite direction. Between 25°c-26°c migrations began toward the right end, which had risen to a temperature of 15°c. At 27°c migrations to the right end were continuous, and at times not a single creature remained in the region of the left end. Tadpoles occupying an intermediate position between the two ends, temperature 18°c, sniffing, as it were, a warmer region toward the left, frequently darted suddenly for it, only to find themselves in hot water, out of which they immediately migrated. The eight thermometers at twelve inches apart registered temperatures shown in Fig. I, Diagram 1. (2) When the temperature of the left end reached 36°c and the right end 26°c the heat was turned off. The left end was allowed to cool by the ordinary process of radiation into the air of the room, while the right was hastened by artificial means. When the latter had fallen to 18°c during 12 minutes, the left end registered 28°c, toward which, but not to it, a slow movement began and increased more and more as the temperature fell at both ends. When the left end had fallen to 24°c and the right

flame to its surface, and thereby protecting the zinc bottom, and second, the water heated in this vessel transmitted its heat to the zinc over a surface equal to the area of the tin vessel ; thus preventing an excessively high temperature in one spot, which would have resulted by a direct application of the flame. Depth of water in trough was two and one-half inches. A board strip containing one-quarter inch holes six inches apart was laid lengthwise of the trough. Thermometers were thrust through eight of these holes, and allowed to dip two inches below the surface of the water.

[1] A summary of these experiments appeared in *Ped. Sem.*, Vol. V, No. 3, 1898.

end to 10°c the migration toward the left were about complete.
A few remained behind entangled in the ice, besides a few
scattering ones at intermediate points, but the great bulk were
huddled in together at the left end tadpole fashion.   The cool-
ing continued until both ends reached, respectively, 18°c and
19°c. The temperatures of the intermediate thermometers were
noted and the number of creatures in the region of each
counted, which is shown in Fig. II.   This is a clear expres-
sion of negative thermotropism at temperatures below 18°c.
Now, since they move away from a temperature of 26°c
toward a lower one, and away from a temperature of 18°c
toward a higher one, it is evident that there must be a temper-
ature somewhere between these two points which is agreeable
or most favorable for the tadpole—its optimum.

(3) The tadpoles were removed from the trough, and the
left end was raised to 35°c, the other reduced to 0°c.   Fifty
fresh tadpoles were then put into the tank at a point register-
ing 10°c. Within five minutes they took the position indicated
in Fig. III.   I removed them from the tank to a vessel con-
taining water at 12°c—temperature in which they were then
being kept, where they remained 45 minutes, after which they
were transferred again to the tank and put in at a region regis-
tering 26°c.   In a very short time the position indicated in
Fig. IV were taken.   The several temperatures were kept
constant for ten minutes, during which time the number at the
temperatures were counted, but at no time were the numbers
materially changed from those already given.   At times there
was more or less moving, now toward the cooler region, now
toward the warmer, but their little excursions nearly always
ended in the region between 19°c and 24°c.

The conclusion is that the optimum for the tadpole is be-
tween 19°c and 24°c.   This conclusion is supported by three
other facts. (1) Their respiration curve rises very suddenly at
24°c.   [See Chart I].   (2) The maximum amount of CO_2 is
produced between 19°c and 24°c.   (3) Their refusal to eat in
temperatures above 24°c.   (They will eat, however, in tem-
perature as low as 10°c).   The curves[1] of Chart I indicate the

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[1] The apparatus consisted of a tall narrow glass jar, depth 28cm, and
diameter 9cm.   It was filled with water.   The tadpoles were confined
within narrow limits, and prevented from direct contact with the bot-
tom of the glass jar by a partition spaced off by two circular pieces of
wire gauze 8.5 in. diameter, placed horizontally in the jar 6.5cm apart.
These two wire platforms were held *in situ* by a wooden rod thrust
through their center and resting on the bottom of the jar, which was
placed in a sheet-iron kettle containing five liters of water.   The bot-
tom of the glass jar was allowed to barely touch the surface of the
water in the kettle.   These conditions secured a slow and uniform
rise in temperature.   Two thermometers were placed at different
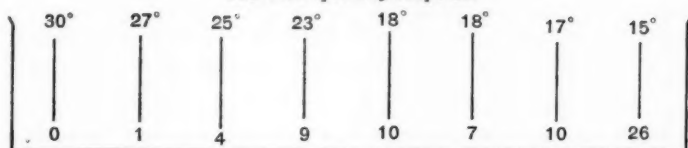levels within the space confining the tadpoles.

DIAGRAM I.

Thermotropism of tadpoles.

30°	27°	25°	23°	18°	18°	17°	15°
0	1	4	9	10	7	10	26

FIG. I.

19°	17°	16°	14°	11°	8°	5°	0°
49	7	4	2	1	0	1	3

FIG. II.

35°	32°	26°	23°	21°	10°	5°	0°
0	0	6	28	8	4	2	2

FIG. III.

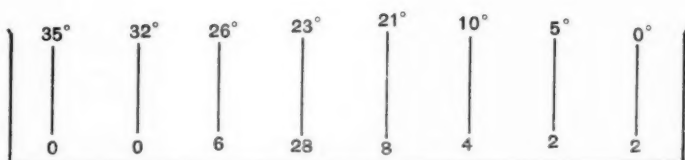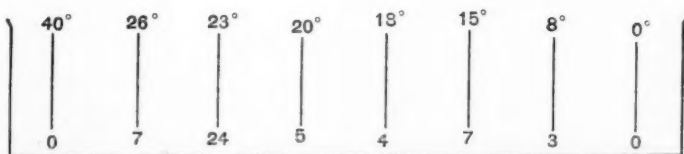| 40°	26°	23°	20°	18°	15°	8°	0°
0	7	24	5	4	7	3	0

FIG. IV.

The vertical lines represent thermometers. The lower row of figures indicate the number of tadpoles in the region of different temperatures. The upper row of figures indicate temperature in degrees centigrade.

effect of rising temperature on the respiration of tadpoles. The temperature was raised from 0°c to 30°c in 165 minutes, or 1°c in 5.5 minutes. The lean, unfed tadpoles began to breathe at 4°c, those well-fed at 6°c. At these temperatures I was able to count from 20 to 24 respirations per minute. Often,

CHART I. *Respiration of tadpoles in rising temperature.*
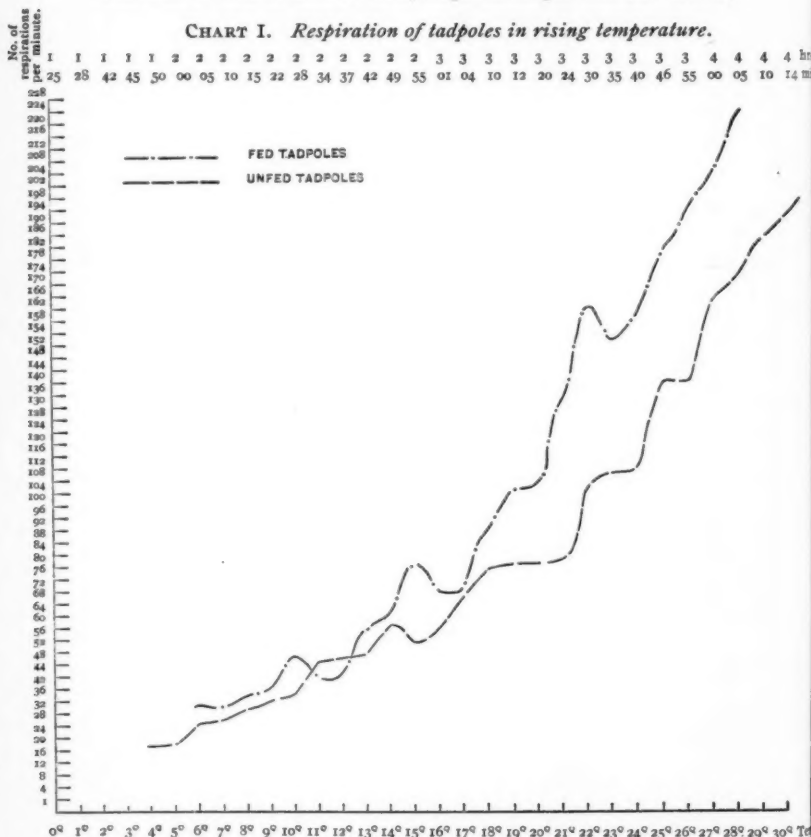
however, no respiration could be detected below 5°c. From 5°c up to 20°c the increase is quite uniform. At 21°c the obese tadpoles increase their respiration 54 to the minute, the lean ones defer any sudden rise until 24°c. Divergence in their curves begin at 17°–18°c. Attention is called to the

fact that the increase in respiration from 24°c to 30°c, or through 6°c equals that from 5°c to 24°c, or the increase through 19°c. Thus showing that any increase of temperature above 24°c produces effects altered in character to those of like increments below that point.   Another inference made here is that, since metabolism is a function of respiration (taught long ago by physiologists), and that the latter stands in causal relation to temperature, metabolism bears a vital relation to temperature. The second part of the problem was to enquire more closely into the nature of this relation. What is the quantitative difference between the metabolism at the optimum and at temperatures above and below that point, as indicated by carbon dioxide[1] produced at different temperatures?[2]

The determination of CO_2 produced by air breathing animals is usually effected by aspirating the exhaled air over barium hydrate or a soda solution contained in Pettenkorf or U tubes. The difference in the weight of the tubes before and after the aspiration of the expired air is taken as the weight of CO_2 produced after making certain corrections.

With water breathing animals the problem is more complex. Water is a solvent of carbon dioxide. The extent of the solvency depends on the temperature and pressure. In this instance the normal pressure was lessened by the aspirator employed to supply the water containing the tadpoles with oxygen. This diminution of pressure favored the escape of a portion of the carbon dioxide from the water. The problem narrowed into the estimation[3] of the carbon dioxide left in the water and of that which continually escaped into the tubes. The amount found in the former I have termed the " volumetric

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[1] The inference that a quantitative determination of CO_2 is a measurement of metabolism is based on the following well-known facts: " Oxygen is concerned with the integrating, the anabolic process, on the other hand carbon dioxide is one of its several disintegrating or katabolic products. These two constituents are not only always present in metabolic processes, but are of such prime importance to the process that a quantitative determination of either or both is a fair measure of metabolism itself." . . . Quoted from article on Truancy, *Ped. Sem.*, Vol. V, No. 3, p. 383.   See same article for literature on the relation of O to CO_2 in life processes, also Howell's American Text-book of Physiology for criticisms on the constancy of the ratio of the oxygen absorbed to carbon dioxide produced.

[2] It is not the purpose to determine the absolute amount of metabolism, such a task is some distance ahead present laboratory methods. The object here is to estimate the relative amounts at different temperatures, and regard these quantities as merely indices to what the absolute quantity may be at a given temperature.

[3] The apparatus consisted of a three mouthed glass jar, capacity seven liters. The jar was connected on one side with U tubing and a gas meter — the tubing was filled with pumice stone and concentrated sulphuric acid — and on the other with a series of seven U

TABLE I.

Showing the amount of CO_2 produced per hour per kilogram of Tadpole at different temperatures.

Experiment.	[1]No. of tadpoles.	Time.	Air aspirated.	Weight of tadpoles in grammes.	Volumetric portion of CO_2 exhaled	Gravimetric portion of CO_2 exhaled	Weight of CO_2 produced per hour.	Weight of CO_2 produced per hour per kilogram of animal.	Temperature Centigrade.
No. 1,	10	5 hrs.	45.88 Liters.	91 G	.225 G	.1955 G	.08410 G	.924 Grams.	20°
" 2,	10	$5\frac{1}{2}$ "	43.7 "	93 G	.015 G	.1789 G	.03875 G	.416 "	7°–8°
" 3,	10	5 "	43.14 "	98 G	.195 G	.2041 G	.07982G	.814 "	15°
" 4,	10	$4\frac{1}{6}$ "	65.71 "	98 G	.075 G	.2105 G	.06963G	.71 "	26°–27°
" 5,	10	$4\frac{1}{4}$ "	67.93 "	97 G	.120G	.2074 G	.0770 G	.793 "	30°
" 6,	10	5 "	60.64 "	88 G	.180 G	.1980 G	.0756 G	.859 "	22°

[1] The tadpoles were in a high state of feeding, and undergoing rapid metamorphosing. Chapman and Bru-
baker have shown that in the case of two pigeons, one, fat and well fed, produced per hour twice as much CO_2
as the second, poorly fed and lean in flesh. Further, Richet—Archiv. de Phys. Normale et Pathologique, 5th
ser., Vol. II, pp. 17–30, 1890 — has shown that in the same species the quantity of CO_2 exhaled is inversely pro-
portioned to the body weight and directly proportioned to the body surface. In the above calculations the
weight of ten tadpoles is treated in the calculations as though it were the weight of a single animal. It is
evident that when the sum of the body weights of any two animals equals that of a third animal, their body
surface is much larger and according to Richet's law exhale more CO_2 than a single animal of equal weight.
To illustrate : Take the weight of the ten tadpoles of experiment and regard it as the weight of one animal,
the body surface would be 226.24 sq. cm., but regarded as the weight of ten animals of the same species the body
surface equals 470.4 sq. cm., or twice the area of a single animal of that weight. It is evident that a plus cor-
rection for body weight might properly be made and thus *lower* the amount of CO_2 exhaled per kilo. of animal.

portion,''[1] and that found in the latter the ''gravimetric portion.'' The sum of the two being the whole amount exhaled. A detailed statement of the experiment and results are given in Table I. This Table shows that a maximum amount of CO_2 is produced at the optimum, 20°c, and that the amounts decrease for temperatures above and below the optimum and further that the fall is much more rapid toward the lower temperatures than toward the higher ones. [See Curve in Chart II.] If then we regard the production of CO_2 as a fair index of the amount of normal metabolism in an organism we are justified in the conclusion that for this species of embryos, maximum metabolism is coincident and very probably a function of optimum temperature. Page's[2] experiments on the dog show that a minimum amount of CO_2 is produced in a temperature of 25°c and that the amount increases above and below 25°c, which is probably about the optimum for this mammal. [See Curve in Chart II.] Thus the warm[3] blooded animal presents reverse conditions.[4] The fact emphasized here, however, is

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tubes and a large Waulff flask. The first and seventh tube contained concentrated sulphuric acid and pumice stone, the first caught any organic matter issuing from the jar containing the tadpoles, the seventh caught organic and moist particles coming from the Waulff flask at times of a negative pressure, the remaining five tubes contained potassium hydrate slightly moistened. The difference in the weight of these tubes thoroughly dried and corked, before and after the aspiration is the weight (with one correction) of the CO_2 that escaped from the water.

The estimation of the amount of CO_2 that remained behind in the water was made by the quantitative method devised by Pettenkorfer, (For description see Fresenius, Quant. Anal., Amer. Ed., p. 834.)

[1] The water to be tested was siphoned from the jar into a 100cc burette and from thence into a bottle corked with ground glass. The CO_2 of the air in the room and of the water used was deducted from the sum of the ''volumetric'' and ''gravimetric'' portions. The air aspirated was corrected for temperature and pressure. The CO_2 in the room was determined by both the Lunge and Regnault methods. The CO_2 of the tap water was determined by the Pettenkorfer method.

[2] Page: External temperature affecting the amount of CO_2, Jour. of Phys., Vol. II, p. 228, 1879-80.

[3] Body temperature of warm blooded animals is kept constant by all parts of the body being constantly oxidized, so that when the external temperature is low much burning is needed to maintain the requisite temperature, and consequently much carbon produced; also if the external temperature is above that of the body it hastens oxidation. That the relative amounts of CO_2 produced at any temperature below the optimum for cold blooded animals should bear a direct proportion to that temperature is evident, but why the amount should decrease above the optimum is not so clear. It is suggested that probably the higher temperatures destroy or disorganize the normal physico-chemic life processes, since the heat rigor of tadpoles is reached at 34° — 35°c.

[4] Edward Smith shows that the quantity of CO_2 given off in man is inverse as the change of the temperature; the vital changes lessening with increase of temperature. Food, p. 11.

that there is a comparatively *fixed rate* of metabolism in optimum temperature for both species.

The next question of importance is, what effect has maximum

CHART II.

Curves showing the relation of the production of CO_2 at different temperatures for dog and tadpole.
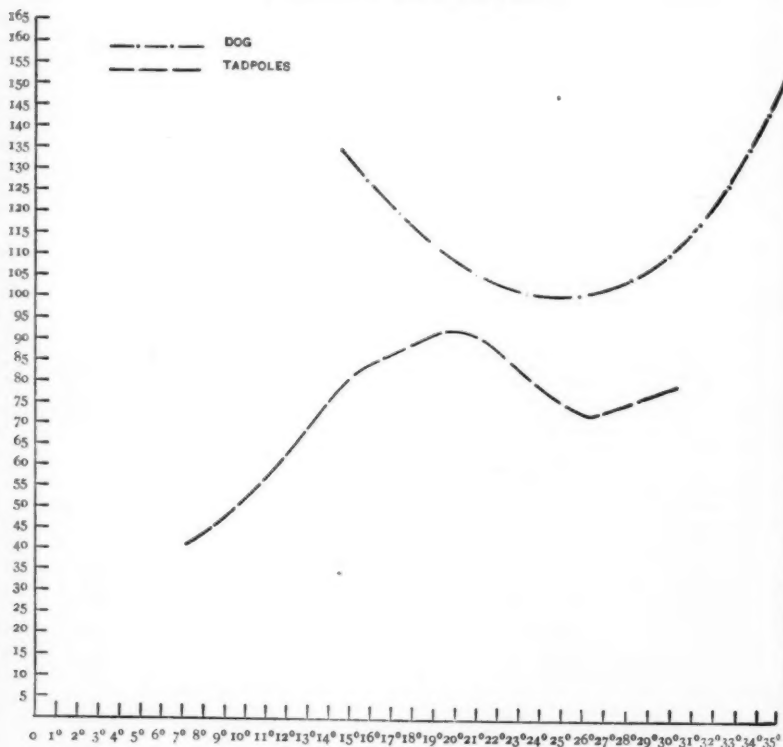
metabolism on the tadpole, as a whole? To secure experimental evidence on this point a group of ten tadpoles was subjected to their optimum for two months. A second group of

10 were kept in a temperature[1] varying from 6°–8°c below their optimum the first month and 4°–7°c below the second. The results are given in table II, which show that the tadpoles enjoying their optimum increase more rapidly in both weight and length. [2]

It appears then that optimum temperature, maximum metabolism and most rapid growth are causally related ; another

TABLE II.

Showing the rate of growth of ten tadpoles in their optimum temperature, and of ten others in 4°c.–8°c. below the optimum.

Date.	In Optimum.				Below Optimum.				Difference of Increase.	
	Wt.	Gain.	Length.	Gain.	Weight.	Gain.	Length.	Gain.	Wt.	Length
Nov. 28, 1896.	39 Grs.	—	7.11 cm.	—	38.5 Grs.	—	6.81 cm.	—	—	—
Dec. 26, 1896.	45 "	6 Grs.	7.57 "	.46 cm.	43 "	4.5 G.	7.16 "	.35 cm.	1.5 Grs	.11 cm.
Jan. 26, 1897.	50.2 "	5.2 "	7.88 "	.31 cm.	47 "	4 "	7.41 "	.25 "	12 "	.06 "

inference is, that the optimum is chosen because that particular temperature is a factor in the organism's well-being, that it affords just that temperature stimulus necessary to set agoing the physico-chemical activities in harmony with that pitch or rhythm which natural selection has determined for that species. The same interpretation, in the absence of conflicting evidence, may be extended to all thermotactic organisms, *i. e.*, a positive thermotactic response is an effort of the organism, guided by the " differences in the intensity of heat to which the two poles

[1] Two glass jars of same shape and size were used. They contained equal quantities of tap water into which was put same kind and as near as possible equal amounts of grasses and foods. The jar, in which it was desired to keep a known and constant temperature, was placed in a copper kettle containing on an average nine liters of water. The bottom of the glass jar barely touched the surface of the water. In this way the temperature of the water in the jar was maintained between 20°c – 23°c. The temperature of the second jar varied with that of the room, which during the months through which the experiment extended fluctuated between 12°–18°c. The experiment was extended through the months of February and March, but serious and frequent mishaps set in that rendered the results worthless. Although the experiment ran smoothly during the months reported, the force of the results is weakened by the short period of the experiment.

[2] Drs. Davenport and Castle report tadpoles as growing more rapidly under constant temperature of 24°–25°, then those subjected to 15°c. The results of my experiment had been described some time before their work came into my hands.

of the body are subjected,'' to seek a temperature, in agreement with its physico-chemical constitution.[1]

Malling-Hansen's[2] discoveries of the intimate relation between temperature and growth of man are quite pertinent to our present problem. He demonstrates a rhythmic response of growth in both weight and height to the large and small portions of the sun's corona as they are successively presented to us by the sun's $27\frac{1}{3}$ days' rotation. The greatest height of the growth curve is coincident with the time in which the larger sector is presented, as this recedes, thus lessening the output of solar heat toward us, the curve falls, but rises again, though not so high, when the small sector of the corona is turned on us. That is, there are two waves of the growth curve comprehended within about $27\frac{1}{3}$ day period, which waves are coincident with the earthward appearance of the large and small sectors of the corona. This is interpreted as a delicate cosmical adjustment of life to temperature.

Enough has been said of only one of the cosmic factors to illustrate its delicate adjustment with life. But it is difficult to see, even though we were to consider every possible cosmic factor from the same point of view, how they have been effective in either bodily or psychic differentiation until we consider some of the inherent properties of protoplasm itself.

How does it conduct itself along the narrow path marked out by cosmic forces? The laboratory attempts to answer the question, in part, by experimentation which aims to test the capacity of protoplasm for acclimatization.[3] These experiments include acclimatization to[4] chemical agents,[5] to [6]desiccation, [8]temperature,[7] changes[9] in food, etc. The general verdict is that protoplasm is *automatic adjustable*, that it *husbands*, and *profits* by its *experience* within its *milieu*. It appears that the teachableness and the ability to profit by it are among the chief distinguishing features of protoplasm. In fact the history of morphology, of adaptation, of evolution itself is writ

[1] '' It (protoplasm) is highly sensitive to changes in temperature . . . . . migrating if possible so as to keep in the temperature to which it is already attuned.'' Davenport, Experimental Morphology, p. 263.
[2] Malling-Hansen: Perioden im Gewicht der Kinder und in der Sannenwärme, Copenhagen, 1896.
[3] Davenport, C. B.: *loc. cit.*, pp. 27-32 ; 65 ; 85-88 ; and 249-58.
[4] Sewall, Henry: Experiments on the Preventive Innoculation of Rattlesnake, Jour. of Physiol., Vol. VIII, pp. 203-210, 1887.
[5] Loew, O.: Ueber den Verschiendenen Resesturf grail im Protoplasm Arch. f. d. ges. Physiol., Vol. XXXV, pp. 509-516, 1885.
[6] Lance, M. Denis: Sur la reviviscence des Jardigre des comp. Rend., Vol. CXVIII, pp. 817-818, 1894.
[7] Mendelssohn: *loc. cit.*
[8] Semper: Animal Life, p. 133.
[9] Davenport, C. B.: *loc. cit.*, pp. 253-254.

large with the effort of life to secure the completest adjustment possible both on the bodily and psychic sides.

The delicate adjustment between life and cosmic forces, the continual effort of life to maintain this adjustment, on the one hand, and the rhythmical, periodical manifestation of the migrating instinct *par excellence* on the other, suggest the importance of considering the mode or nature of the interaction between life and external forces.

According to Fiske [1] and Spencer [2] all cosmic forces obey a rhythmical motion which is a corollary from the persistence of force.

We may reasonably assume that the primitive *megazoön* found itself in this maze of cosmical rhythms. Heat, light, sound, wind, electricity, etc., beat upon these primordial creatures in rhythmic waves. We may imagine that one of the first tasks of this life was to get in rapport with these innumerable cosmic movements.

In fact existence, survival itself, and the evolution of the organism were conditioned largely on a rhythmical adjustment to the inorganic forces of creation. "Those [3] spontaneous compounds whose internal rhythms chance to accord with the external rhythm enjoy the greater probability of survival and thus rhythmic interaction between the internal and the external may be developed through the exclusion of the non-rhythmic, elimination of the ill-rhythmic and the preservation of the duly rhythmic." What is this adjustment but a continual effort of life functions to operate in unison with cosmic rhythms. Accordingly we find rhythms prevailing through all life processes both physiological and psychical.

The elaboration and assimilation of food into the body tissue in excess of waste and repair is rhythmical, that is to say, [4] growth obeys this law. The [5] menstrual life is associated with a well-marked wave of vital energy which manifests itself in the temperature of the body, in the pulse rate, etc., etc. These several phenomena have a striking coincidence to both the lunar period and sun's rotation. The [6] pulse shows an annual rhythm maximum in winter and minimum in summer. The daily bodily [7] temperature is higher in the evening than that of the morning. The return of zymotic diseases in some countries show a remarkable regularity and appear to stand in

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[1] Fiske, John :   Outline of Cosmic Philosophy, Vol. I, pp. 297-313.
[2] Spencer, H. :   First Principles, pp. 256-257.
[3] McGee, W. J. :   Earth the Home of Man, p. 5.
[4] Malling—Hansen :   *loc. cit.*
[5] Stephenson, Wm. :   Am. Jour. Obstet,, Vol. XV, 1882, pp. 283-294.
[6] Coste F. H. Perry :   Nature, Vol. XLIV, 1881, p. 35.
[7] Bucknill and Tuke :   Psychological Medicine, 4th Ed., p. 317.

causal connection with certain climatic elements. In India,[1]
for example, the fluctuations of the death rate by fever coin-
cide with the variations in the range of temperature.

That these innumerable cosmical and physiological rhythms
have greatly influenced the soul and have stamped upon it
highly colored rhythmical activities are evidenced in every
period and condition of human history, in every field of human
thought and feeling.[2] It is manifested among primitive
peoples by the readiness and completeness with which they
surrender themselves to music and dancing, by their strict
observance of annual festivals and celebrations.

The early mind was impressed by this universal principle.
Their gods and demons did things rhythmically. They visited
the earth, made war and peace, and discharged their hercu-
lean tasks for the most part with strict periodicity.[3]

Spencer has pointed out that philosophic thought obeys this
principle. Now Platonic idealism is all-pervading, now the
materalism of a Hobbes, then the ebb of Hegelian idealism
gives way to the flow of materalism of the third quarter of this
century.

Further, our volitional nature pulsates rhythmically. Mar-
riages[4] in every country show a more or less periodicity.
The time of the year for marrying in different countries is
somewhat influenced by custom, religious beliefs, harvest[5]
time and the *return of spring*.

[6] Leffingwell raises the question concerning the influence of
spring upon the ratio of legitimate to illegitimate births.
"Among human beings is there yet remaining any trace of
that instinct which leads birds to mate when winter goes, and
which in earlier periods of man's development was perhaps
as strong as with other animals?" "If it exists should we
find any difference in and out of the marriage relation?" The
birth rate of [7] France, Norway, Sweden, Holland and Italy

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[1] Hill, A. S. : Nature, Vol. XXXVIII, 1888, p. 245.
[2] The psychological aspect of the subject is treated indirectly in
every modern exposition of sound, retinal revelry, fatigue and atten-
tion. Bolton has treated the subject directly and especially as it is
manifested in music, verse and poetry. *Am. Jour. Psy.*, Vol. VI, pp.
145-238.
[3] Kelly, W. K. : Indo-European Traditions and Folk-Lore.
[4] Farr, Dr. William : Vital Statistics, p. 76, London, 1885.
[5] Hill, A. S. : Nature, Vol. XXXVIII, p. 245, 1888.
[6] Leffingwell : Influence of Seasons upon Conduct, p. 115.
[7] Observations tend to show that the largest number of conceptions
in Sweden fall in June; in Holland and France, in May-June; in
Spain, Austria and Italy, in May ; in Greece, in April. That is, the
farther south the earlier the spring and the earlier the conceptions—
Mayo-Smith, Statistics and Sociology, 1895. In Massachusetts the
largest number of marriages is shifting from late fall and the New
Year, which prevailed down to 1870, to April and June—Mass. State
Board of Health, 1896, p. 731.

show that the ratio of illegitimate births between the spring—summer months and the fall—winter months is greater than the ratio of the legitimate births covering the same period. The ratio of the totals for the countries just named for legitimate births between spring—summer months and fall—winter months is 24 : 23 and for illegitimate births for the same periods the ratio is 26 : 22—pointing to a permanent seasonal influence on the reproductive functions and to the genial effect of spring upon the procreative functions. More striking, however, is the evidence of periodicity in the tendency to those relationships which occasion illegitimate births. Under like conditions the excess of the seasonal ratio of illegitimate births over that of the legitimate is a direct expression of the remnant of that passion implanted in man when pairing in spring time was almost universal. The strength of the reverberation of this passion is inversely to the respect for the prevailing customs, religion and law.

The relation between spring and certain bodily and mental conditions finds emphasis in a large group of phenomena arising from *spring fever* and *ennui*. The following are typical cases of one hundred and twenty received on that subject. (See Syllabus, Rubric XII.)

1. M., 20. Whenever I am afflicted with what I have always called spring fever I feel sleepy and tired and have no ambition to study.
2. F., 19. Feel sleepy, languid, no ambition; strength seems to have left me, and every duty seems a great trouble.
3. F., 17. I have no power of concentration, feel that I must be out of doors all the time, am drowsy and ache all over. Like to sleep—can eat only certain things.
4. M., 25. Was physically weak, or rather inert, so that I could hardly drag one foot after the other and the queerest longings beset me—now for a gust of wind to fan my face, now for an apple (would have given almost anything for an apple once), and then I wished intensely for a swift ride. This fever of queer, delicious lassitude and longing lasted nearly three weeks and during that time I was of practically no use on the farm.
5. F., 16. Felt as though all energy had fled, and that I was such a weak mortal—not fit for this life which needs so much energy and brightness.
6. F., 18. Wanted to sleep, or meditate, or dream the time away. It seemed too much trouble to think, to speak or to act. Some very romantic or thrilling story interested me somewhat, but I soon wearied of it.
7. F., 19. I wanted to lounge around in the open air—never want any one to bother me.
8. F., 17. I feel tired of everything, and that I cannot drag out another day—things are weary, stale, flat and unprofitable.
9. F., 18 Could I only break away and go somewhere by myself where the sun is bright and warm and where I can hear birds singing, find a nice comfortable position and spend my time in day-dreaming, I should be perfectly happy.
10. F., 17. Felt as though there was absolutely no life in me and

that I should go wild if I did not get away from everybody and be alone in the wood or on the water in a quiet bay.

11.   F., 22.   Lose interest in my work, study is a burden.   The feeling is impossible to describe.   It is a longing for something, I know not what.   Often I have sat quietly and tried to analyze it but cannot.

12.   F., 19.   I feel dull, drowsy, can't hurry, prefer to drag along as I please.   Sometimes I like to walk slowly along some shady path or sit down under a shady tree and dream my life away.   I have had a desire to be married and have a home of my own.   I think I have planned where it shall be and how furnished, a dozen times.   Perhaps it is very foolish ; but I do it very often.

13.   M., 30.   This spring a strong wave of sentiment came over me to see an old chum and sweetheart.   I could hardly restrain myself from setting out instantly to see her which would have been a long journey.

14.   F., 20.   Spring fever affects me most about June or when school closes.   Then I have a great longing to skip two years.   This longing is connected with love.   I expect to have a house of my own at that time, and O ! how anxious I am to see that time.   It is hard for me to work patiently.   I like my studies because they take my mind away from thinking too much about this much desired thing.

15.   M., 26.   I feel most these impulses as often as once a month, at least.   And when school is over the tendency is irresistible.   I always rush off somewhere.   I feel every year as though so much of student life was becoming unendurable.   I must get out and do something.   I often feel so in regard to love.   It is the Lord of promise. I feel oftentimes as if I had waited long enough, and I must fall in love with and marry somebody.

16.   M., —.   Physician says : " In my youth I had frequent attacks of ennui, and sometimes desired to break away from home and see the great world, but since blessed by a good wife and daughter and a pleasant home, together with more philosophic views of life which came with age, such feelings have gradually faded away."

Longing in the distance, desire for wider liberties and space, hunger, are often strongest at this period.   (100 cases of this group.)

17.   F., 38.   From the age of 20 to 30 I felt spring fever strongly, longed to see strange sights in other countries, felt myself hemmed in and stifled.

18.   F., 19.   I have often felt during the spring months as if I would like to find employment among strangers—never desired to go any great distance away from home.

19.   M., 22.   I longed to be out of doors, and to sit under the trees alone and meditate.

20.   F., 19.   The feeling of longing in the distance comes over me at this time.   I try to think what it is, but I cannot.   There seems to be something. I have often thought how I would like to have a family, how I would enjoy taking care of the children.

These cases interest us only so far as they contribute evidence to the proposition that there are still left remnants of instinct feelings interwoven and combined with the reproductive functions that stand in causal relation with the cosmic forces of spring time.   To summarize the general and salient characteristics : the majority report a tired, languid, worn-out

feeling; a feeling of lassitude; a restless, trembly nervous feeling; a dull, drowsy, hesitating condition. Many complain of headache, no life or energy left, felt as though the blood had ceased to circulate. The air of the room feels poisonous, stifling and suffocating. They long for fresh air, to get out under the wide sky, to lounge and sleep, to lie on the grass and have bugs and beetles crawl over them, to be let alone, to sit down quietly and read, to sit under a shady tree and be read to, to dream, to meditate, to walk slowly in shady paths, to sit quietly in a boat in some secluded bay. Some become quite anti-social and want to be let alone. They wish to forget work and duty. It is hard to think, to concentrate, to direct the attention. Work is distasteful and unsatisfactory. They lose interest and ambition in the work of the moment, and desire a change.

Others wish to begin life anew, to enter upon some great and uplifting work, to be a good samaritan, to be independent, to make a success of things, to cross swords with the world. Many state that they experience passions of love, desire to be married, day-dream over their future home, how it shall be built, how furnished, and how they will delight to care for the children.

These passions, dreams and fancies do not always pass away as such, but according to statistics already quoted express themselves by increasing the number of marriages and conceptions during the vernal season. Could it be that lassitude, restlessness, the inability to think, to concentrate the attention, so frequently mentioned, are due to the shifting of the main bulk of the metabolic processes from the vegetative to the reproductive functions. The fact that thought processes—especially attention—are associated with increase blood supply to the brain, lends color to the view, that when thought is difficult—in the absence of fatigue and other ordinary causes—an increased blood supply is attracted to the reproductive organs.

A very interesting and instructive correlation exists between the age of the individual and the season of the year in which running away from home occurs. (See Chart III.) From one to eight by far the majority leave during the summer. At four, spring takes the lead of autumn and winter, and continues to increase until the seventeenth. The summer curve begins at eight, to fall gradually until at ten, where it follows closely the autumn and winter curves to the sixteenth year, joining the spring curve at seventeen. The feeble and even height throughout all ages is noteworthy in the winter curve. The same description applies to the autumn curve, save that it is higher at the majority of ages, especially at nine and ten,

where it even rises above the summer curve. These two
curves regarded separately contain but little interest, merely
showing that all ages behave about alike at these seasons ; but
when compared with spring and summer they indicate that
man, like the rest of organic life, hovers about his hibernating
quarters.   The spring curve, though interesting even alone,
derives additional import by comparison with those of the
other seasons. From one to seven the number leaving in spring
are about equal to those of autumn and winter. At eight the
curve makes a considerable rise, leaving the winter and autumn
curves far below. Doubtless the phenomenal rise at this age
is associated with the child's love of nature and the varied out-
door activities paramount at this period of childhood. The
spring runaway is a reaction against the prison life of winter,
together with a strong tendency to revel in the out-door
charms of spring. Chart IV shows that the nature curve
attains its greatest height from eight to eleven, inclusive. A
second and larger rise occurs in the fourteenth year, which
continues through three successive years, falling slightly in
the fifteenth year.

Now from one to twelve years or thereabouts, the child is
neuter respecting much that belongs to both primary and sec-
ondary sexual differentiation. Up to this time he is a vegetative
animal, his activities being determined by atavistic tendencies
and by forces that affect the vegetative functions.   At about
the thirteenth year, however, the physiological[1] changes and
peculiar psychosis that take place as a result of the functional
development of the reproductive organs expose the organism to
a new play of forces that eventually topple the unsettled phys-
iological and psychical elements over into a field of periodic
activities recognized as sexual, or as irradiations of these func-
tions.

Considering the data as a whole, that furnished by mar-
riages, spring fever psychosis, and that of the runaways, we
are justified in the inference that both youth and manhood up
to thirty odd years, are more susceptible to the feelings of sex
and its irradiations at that season of the year when the "will
to live" is making a universal effort.

Thus far I have tried to develop three general notions : (1)
the delicate and vital relation that exists between life and cos-
mic forces ; (2) that the first and most fundamental effort of

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[1] For literature on these changes see Ranke: Grundzüge der Phys-
iologie, 1881. Das Volum des Herzens und die Weite der grossen
Arterien-Pubertätsentwickelung des Herzens S 490-94 ; Lancaster :
Ped. Sem., Vol. V, No. 1. The Psychology and Pedagogy of Adoles-
cence. Donaldson: Growth of the Brain, also Clouston : Neuroses of
Development.

CHART III. Showing the relation between the season of year, the manner and age of the runaway.

NO 253	IMPULSIVE
" 214	PLANNED
" 144	SUMMER
" 148	SPRING
" 70	WINTER
" 78	AUTUMN
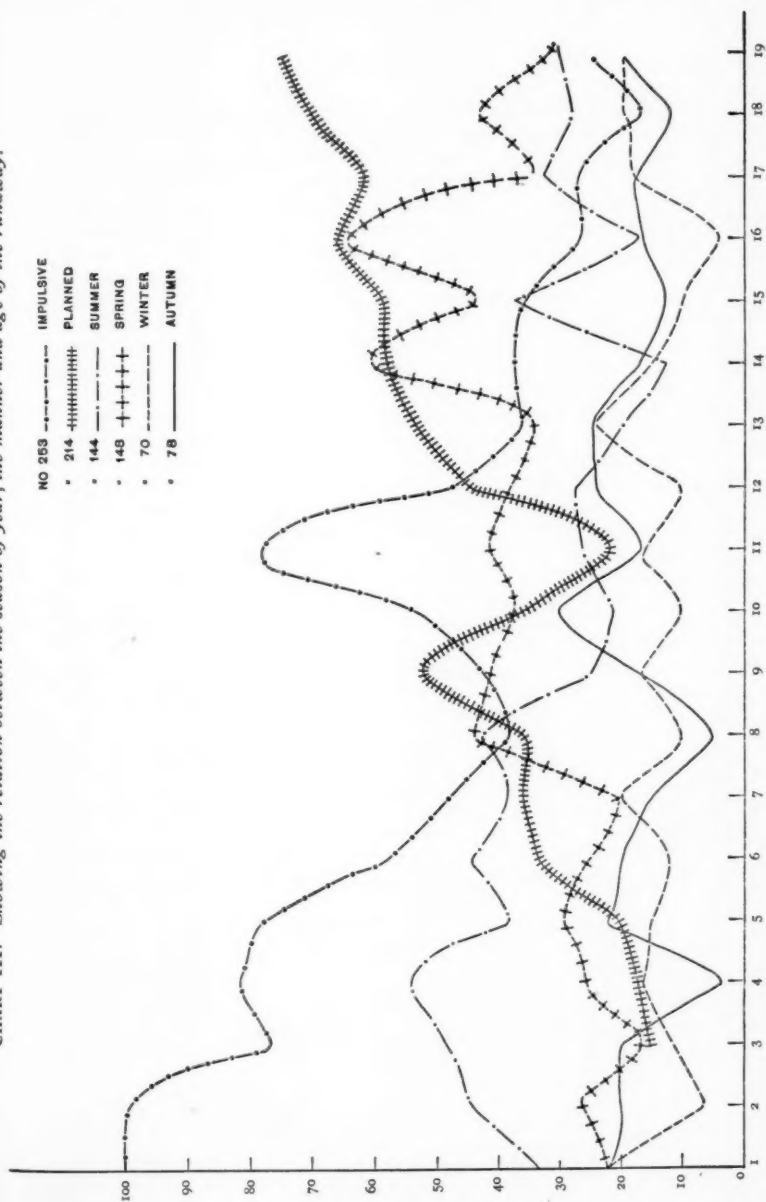
life is to keep in rapport, in attune with cosmic and, I should add, social forces ; (3) that as a result of the first two conditions life processes, both psychical and physical, have become rhythmical ; and that the higher the organism the more complex the rhythmical adjustment, *e. g.*, the savage must keep in unison with his tribe. He must hunt, dance, fight and celebrate victories with his fellows. The life of the modern man is a web of rhythms ; he must not only respond with the rest of creation to cosmic rhythms, but also to the manifold periodicities of civilized life. He must keep in unison with the movements of his trade, with the pulsations of his profession and his society. He must keep step with the fads and whims of his club or drop out.

The thesis maintained here is, that migration is *one* method adopted by an organism to maintain its psycho-physiological activities in attune or rhythm with those of the organic and inorganic world.

It has become a universal mode by which organisms restore and maintain the factors essential to their well-being, be it for light, heat, pressure, food, relation to society, position in trades, profession or what not. It is the mode employed by nomadic[1] societies[2] to make good the exhaustion and failure of the food supply, by the peasant who comes to America, thereby relieving the pressure of oriental social conditions. The pilgrimages to Rome, Jerusalem and Mecca, are efforts to maintain a more complete adjustment to certain complex religio-sociological customs and rites.

The children's Crusade[3] at the beginning of the 13th century is perhaps an illustration of the greatest attempt of a body of human beings to regain peace and well-being to the body and soul by migrating.[4] Coxey and his army, as others have done elsewhere, embraced the principle to relieve their social and economic strains and stresses. The planomaniac breaks the monotony of the home by daily gadding the street.

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[1] Spencer, Herbert : Synthenic Philosophy, Chapter on Rhythm.

[2] McGee, W. J.: Amer. Anthro., Vol. VIII, No. 4, 1895.

[3] The history of that period records that war and turmoil were everywhere supreme. Desolation and poverty covered vast districts ; starvation entered many homes. Society was disorganized, law and religion a mockery. No time for reading or study,—the densest ignorance settled over the land. In the midst of all this St. Bernard came preaching the failure of the preceding crusades, due to the sinfulness and wanton folly of the pilgrims and soldiers. The Holy Sepulchre must be reclaimed by innocent hands. Who were such ? The children of the land : accordingly 20,000 German boys and girls, 10 to 16 years of age, and 30,000 from France at once took up the cause which so soon ended in every form of misery.

[4] Gray, Geo. Z.: The Children's Crusade or an Episode of the 13th Century.

The well-to-do-citizen, and globe-trotter yielding to the popular fashion joins the annual summer wave of European tourists. The American student to hold his place at the crest of his profession feels it necessary to join the semi-pilgrimage to European universities.

SECTION A.

MIGRATION OF ANIMALS.

Wild Animals.

This section embodies in a brief form the observations and theories of naturalists on migrations among lower animals.

CRUSTACEANS. "The adult lobster[1] never moves up and down the coast like the migratory fishes, but is of a far more sedentary disposition." In the spring months of April and May, however, large numbers appear to move from deep water toward the shore. In the fall they retire to deeper water again. This is proven from the fact that they are caught in from three to ten fathoms of water from May until November; for the rest of the year fishing is conducted in thirty-five to forty fathoms. If the spring is late and the water cold the lobster keeps away from the shore. The land crabs of the West Indies[2] are generally found in great numbers in holes and cavities among the mountains; but every spring they descend in immense bodies to the coast, ... pursuing so direct a line to the place of their destination that scarcely anything will divert their course. [3] "When they have effected the purpose for which they undertook their journey, they slowly return, weak and exhausted; and not long after, millions of the little crabs, which have been hatched on the shore may be seen making their way up to the mountains."

INSECTS. The predatory onslaught of the locusts has been witnessed over all temperate and tropical regions and has quite a place in history. We read in Exodus: "And the locusts went up over all the land of Egypt and rested on all the coasts of Egypt: very grievous were they. . . . . For they covered the face of the whole earth, so that the land was darkened; and they did eat every herb of the land, and all the fruit of the trees . . . . and there remained not any green thing in the trees, or in the herbs of the field, through all the land of Egypt." Similar descriptions are found in Pliny, Cauch,[4] Figuier,[5] Swainson,[6] Wallace[7] and others of this ruth-

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[1] Herrick: The American Lobster, p. 20, Washington, D. C., 1895.
[2] Heilprin: Distribution of Animals, p. 41.
[3] Swainson: Habit and Instinct, p. 263.
[4] Cauch: Illustrations of Instinct, p. 151.
[5] Figuier: The Insect World, p. 302.
[6] Swainson: *loc. cit.*
[7] Wallace, A. R.: Geographical Distribution of Animals, Vol. I, p. 32, 1876.

less reaper of all kinds of foliage whatever. Such expressions as the following are used in attempting to express their numbers : " Such was its density that when they flew low one person could not see another at the distance of twenty paces." " It totally intercepted the solar light." " Like a shower of snow, when the flakes are carried obliquely by the wind." Mr. Barrow describes a migration of locusts of Southern Africa in 1797. They literally covered an area of nearly 2,000 square miles. When driven into the sea by a northwest wind they formed upon the shore for fifty miles, a bank three or four feet high ; and when the wind was southeast, the stench was so powerful as to be smelt at the distance of 15 miles. Their movements are always with the wind, sometimes preceding a strong wind. The same is true of the well known dragon-fly " storms " of South America. Their migrations, like many other insects, never occur at stated times and seasons as those of higher animals, but depend on various *concurrent* causes ; as the humidity of the preceding season, the intensity and direction of the wind, barometric pressure and food supply. [1] Hudson says : " The cause of the flight is probably dynamical, affecting the insects with a sudden panic and compelling them to rush away before the approaching tempest. The mystery is that they should fly from the wind before it reaches them, and yet travel in the same direction with it." I venture to suggest that their sudden appearance from five to fifteen minutes before the wind storm is due to the well known barometric [2] rise preceding wind and thunder storms.

[3] On the other hand the migrations of several species of butterflies and the nuptial flights of ants obey seasonal and climatic influences. Butterflies (notably the painted lady) fly in huge numbers in France, England, Italy, Switzerland and

[1] Hudson, W. H.: The Naturalist in La Plata, pp. 130-134.
[2] Davis, W. M.: Elementary Meteorology, 1894, p. 250.
[3] Cauch cites several instances of sultry, moist, warm weather interrupted occasionally with showers and thunder storms which were also periods of wave movements of the dragon-fly. " As to the great multiplication of these insects about the end of May in the present year, it is by no means mysterious. From the beginning of that month to the 21st, the weather had been exceedingly rainy ; rivers and lakes overflowed and spread their inundations over immense areas of low grounds, whereby myriads of the pupae of the *Libellulae*, which under other circumstances, would have remained in deep water and become the prey of their many enemies, were brought into shallow water ; and the hot weather from May 21st to May 29th converted those shallows into true hot beds. Numerous thunderstorms (at Weimer there were four) during that week must have greatly encouraged their rapid development into perfect insects ; and so those clouds of winged insects rose almost at once from the temporary swamps and were *immediately obliged to migrate in order to satisfy their appetite as these species are very voracious.*"

Brazil. In the European countries their flight is from south to north during the spring and summer months. In Brazil their movements are from north to south, or from northwest to southeast. They are usually from the dry arid districts of the interior toward the verdant forests of the sea coast during May—June. '' We could mention many facts tending to favor the opinion that all these butterfly migrations are made toward these verdant tracts, for the purpose of breeding or rather of depositing their eggs.'' Huber has associated special climatic conditions with the nuptial flights of insects. '' Let [1] us retire to a meadow on a fine summer's day at a time when they first make use of their wings.'' ''Ants [2] are now and then induced to change their residence. Should it be too much in the shade, too humid, too exposed to the attacks of passengers, or too contiguous to an enemy's quarters . . . . they leave it to lay the foundations of another. This I have denominated migration.'' '' During these flights impregnation occurs, and their wings are shed after alighting.''

FISH. Their migrations are variously classified : in time ; they are either regular, *i. e.*, seasonal, or irregular, many species of the anadromous fishes furnish examples of seasonal migration, long and irregular absences of the bluefish and chub mackerel from our shores represent the latter : In direction, it may be said that they migrate roughly in three planes : (1) a horizontal plane extending toward or from the equator—such movements are largely controlled by temperative conditions ; (2) a plane at right angles to the first, to or from the shores, caused by the fish seeking a stratum of water of an agreeable temperature, and also by the stimulus of the spawning season. Ichthyologists are now of the opinion that movements in this plane constitute the great majority of their migrations ; (3) a vertical plane to which Goode [3] has given the name '' bathic migrations.'' Such movements are controlled by temperature, winds, currents and light. It is generally thought that the causes of these several movements are due to changes in temperature, a desire for suitable places for spawning and to search for food. Winds, currents, light and density of the water are also regarded as minor factors.

The most potent of these factors, however, is temperature. I shall enumerate only a few of the best confirmed observations.

Temperature. The optimum temperature for the menhaden is 60°–70° Fahrenheit, that of the herring is 45°–55° Fahrenheit. The former is a warm, the latter a cold-water species.

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[1] Huber : Ants, p. 96.
[2] Cauch : *loc. cit.*, pp. 148-152.
[3] Goode, G. Brown : U. S. Report, Fish and Fisheries, p. 51, 1877.

Accordingly,[1] when the menhaden desert the Gulf of Maine
they are replaced by the herring. Cold weather drives the
menhaden to the warm strata (bathic migrations), while it
brings the herring to the surface. The relation between the
distribution of herring and the degree of heat in the water
has an important bearing upon the herring fisheries ; '' since,[2]
when the heat of the surface water is above 55°F. herring are
seldom seen ; as this decreases they make their appearance.
This is so well established that now the herring fishery on the
coast of Scotland is largely regulated by the temperature ob-
served, and when it is decidedly above 55° the herring are not
looked for.'' The[3] extent of the catch of anchovies along the
shores of Scotland during the fishing season is (at least largely)
dependent on the temperature of the water during the mid-
summer months of the preceding year.

   Search for Food. Baird observes that oceanic currents have
a more or less influence upon the distribution of fishes. This,
however, depends more upon their pursuit of the less inde-
pendent algæ, jelly-fish, crustaceans, ascidians, etc., that float
hither and thither with the currents. Prof. Möbius (quoted
by Beard), in investigating the food of the herring in the Ger-
man seas finds that the abundance of herring in any one season
is in strict proportion to that of the shrimp. A direct and
combined effect of food and temperature upon fish movements
is found in San Francisco Bay. This bay receives the waters
of two very large rivers, which bring down constantly a large
amount of minute animal and vegetable life, much of which finds
a congenial home in the bay, thus furnishing a large and varied
quantity of food for its fish life. The temperature of the bay
is almost constant, varying only a few degrees at any season of
the year. The constancy of these two most important factors
(food and temperature) throughout the year ought to reduce
migrations to a minimum. Observations confirm this supposi-
tion.[4] The official report reads : '' That the conditions are
extremely favorable to the support of aquatic life is demon-
strated in the rapid increase and *permanent residence* (italics
mine) of the several fine food-fishes introduced from the At-
lantic coast by the government. Some of the fishes thus
acclimatized are naturally anadromous, but in San Francisco
Bay, contrary to their usual migratory habits, they do not
appear to have any desire to spend much, if any, of their ex-

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[1] Goode, G. Brown : U. S. Fish Com. Report, p. 72, 1877.
[2] Baird, Spencer F.: U. S. Fish Com. Report, p. 55, 1886.
[3] Bottemanne, C. J.: p. 340, Vol. I, Jour. Marine Biolog. Ass'n.
[4] Wilcox, W. A.: Fisheries of the Pacific Coast, U. S. Fish Com. Re-
port, 1893.

istence in the ocean." Another[1] example of the sufficiency of food and limited range of temperature checking the wandering of fish is furnished by the menhaden that may be found at all seasons of the year along the coasts of Ga. and S. C. Only a partial migration occurs in mid-winter, which is now believed to extend only a short distance seaward.

Wind, Light, etc. Herr von Freedon (quoted by Goode) finds that warm winds and clear skies of the North German seas are coincident with large catches, and *vice versa.*[2] " A bright sunny day," says Baird, " will frequently call up forms that are never seen at any other time, while others, again, only approach the surface on cloudy days, or even in the night, exclusively." Experts testify that along the shores of Scotland thunder storms of some magnitude and extent affect seriously the quantity of the catch on the following day. If any are caught, it is at extreme depths.

Movements Affected by Enemies. Salmon are known to entirely abandon a particular section of sea coast by the onslaughts of the white whales and porpoises. In[3] the fall of '94, owing to the vast numbers of bluefish and squeteague (deadly enemies of the menhaden) in the vicinity of Montauk Point, large schools of menhaden were detained in Gardiner and Neapeague bays weeks beyond their usual time of departure, and were unable to reach the ocean until their enemies had left. About October 21st the bluefish disappeared, and the departure of the menhaden rapidly ensued. In fact, so great is the fear of the menhaden for the bluefish—a veritable corsair—that the former are known to reverse the course of their annual migrations for several weeks should the latter appear in their front.

Reproductive Instinct. The movements associated with the reproductive period give the clearest evidence of a migrating instinct. Moving from an uncomfortable to a comfortable temperature, seeking light of proper intensity, pursuing and capturing prey are activities of the more simple, reflex type—a reaction to a simple stimulus. True, migrating movements are in obedience to stimulus, but a stimulus of a very *complex* sort, it is *periodic* and *persistent* leading to the execution of large and definite tasks, impelling[4] the species to a particular spot at a fixed time. They are peformances larger than individual ex-

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[1] U. S. Fish Com. Report, p. 40, 1877.

[2] Baird, S. F.: *loc. cit.*, p. 57, 1886.

[3] Smith, H. M.: Bulletin of U. S. Com., 1895, p. 299.

[4] The long journeys of catadromous fish give unmistakable evidence of an inherited activity ("primary automatic" by some authors, "congenital" by others). "This species of fish, represented by the eel, are born in the sea, ascend the rivers and reach their maturity in two to four years, and then, when mature, descend to the ocean to spawn, and possibly never leave it again."

perience, and too clear-cut and purposive to be ascribed to immediate sense experience. As sexual maturity approaches the stimulus, which has its origin in the developing reproductive organs, urges it to leave the ocean and, entering the mouth of a river, to journey upward, often thousands of miles, to its source in the mountains. Classical examples of this sort are the seasonal migrations of the[1] salmon,[2] tunny[3] herring,[4] shad and sturgeon up rivers or into quiet estuaries for the purpose of spawning.

BIRDS. The mystery[5] and superstition that has hovered about bird movements are dissolving before sober and careful observation. The problem is by no means solved, but it has been brought from the region of folk-lore[6] and the mere "wonder[7] stage" and given a seat alongside other unsolved problems as anger, hunger, fear, etc. True, the progress for the past twenty years has been so feeble and unsatisfactory that some scientists[8] discourage theoretical speculations on the subject, regarding them not only useless, but a positive injury to real observations of nature. Despite these backward conditions two groups of theories are set forth. To the first group I have applied for the want of a better term *kinetogenetic*, and to the second group *physiogenetic*; meaning by the former such theories as make food, geological, and the several climatological elements the effective causes in originating the instinct, by the second, the periodic physico-chemical processes that are coincident with the reproductive and moulting seasons.

Kinetogenetic. Faber (quoted by Homeyer) says : "That nature divided every individual into two irresistible impulses ; the wandering impulse (*wanderungstrieb*), and the homesick impulse (heimwehtrieb)." The bird shows the former when it leaves the place of its nativity and repairs to a region usually

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[1] Romanes: Animal Intelligence, p. 294.

[2] "At this time the king of fishes (salmon) is in physical perfection, with few rivals in beauty or strength or fierce energy or indomitable courage and perseverance ; but its strength is soon fully taxed in surmounting the obstacles and in fighting the rivals which oppose its progress, until at last, worn and thin, torn and mangled by battle, and battered by rocks? and whirlpools? (question marks mine) with its skin in rags, its fins crippled and bleeding, ... nothing of its kingly nature remains except the indomitable impulse, which no hardships can quench, still urging it upward, until, if any life is left, it at last reaches the breeding-ground." W. K. Brooks, Pop. Sci. Month, Vol. LII, 1898, pp. 784-85. (Prof. Brooks's article appeared after this section had been written.)

[3] Swainson: *loc. cit.*, p. 263.

[4] Wallace, A. R.: Geographical Distribution of Animals, p. 19, 1876.

[5] Newton : Birds, Ency. Britannica.

[6] Wallace, A. R.: *loc. cit.*, p. 21.

[7] Brooks, W. K.: *loc. cit.*, p. 786.

[8] Homeyer, E. F.: Die Wanderungen Der Vögel, Leipzig, 1881.

characterized by new foods and climatic elements, the latter by its return after a season to its birthplace.

Darwin's theory is that the ancestors of migratory animals were annually driven by cold or want of food, to travel slowly southwards, ... and that this compulsory travelling would become an instinctive passion.

Palmèn[1] undertook in 1876 to verify Darwin's theory from the study of geological history. He worked out in detail nine great routes traversed by birds in their passage from Greenland and northern Eurasia to Africa, southern Asia and the East Indies. A glance at the routes shows that the presence of water in the past and present in the form of rivers, lakes, seas and ocean is the major factor in determining the bends in the course of their flight. These routes pertain to bog and water birds. They are quite circuitous, e. g., the most direct route for the crane living on the shores of the Baltic, to its winter home in northern Africa, is across the Alps and along the east shore of Italy. Its actual route is up the Rhine to near its source, and down the Rhone to the sea, and then along the west shore of Italy and Sicily across to Africa. The most direct route for the wagtail from Greenland to a warmer climate is along the eastern coast of North America, instead of this it strikes boldly out to the S. E., across the Atlantic toward the shores of Norway and the British Isles. Ornithologists are agreed that most of our eastern birds come to us through Mexico, and in returning to their winter homes in Central America, they travel through Texas and Mexico, and are unknown in Florida and the West Indies.[2] Others have come to us through Florida, and in returning to their winter quarters do not pass through either Texas or Mexico. This is best illustrated by the bobolink, an eastern bird, which breeding from New Jersey northward to Nova Scotia, has spread westward until it has reached Utah and northern Montana. But, and here is the interesting point, these birds of the far west do not follow their neighbors and migrate southward through the Great Basin into Mexico, but . . . . retrace their steps 'and leave the United States by the roundabout way of Florida, crossing thence to Cuba, Jamaica and Yucatan, and wintering south of the Amazon.'' While in some cases the relation of the route to the conditions for procuring food is clearly evident, in species like the wagtail, eiderduck and bobolink, no such relation exist at present. This fact brings to the front the permanency of the routes, and fully justifies the inference that not only the impulse to migrate, but also the direction, is an inherited tendency.

[1] Palmèn, J. A.: Die Zugstrassen der Vögel, Leipzig, 1876.
[2] Chapman, F. M.: Bird Life, Appleton, 1898.

The bobolink of Utah did not learn their route in one generation ; they, in all probability, inherit the experience of countless generations, slowly acquired as the species extended its range westward. But how shall we account for the eiderduck, the wagtail and puffin, wholly disregarding land forms in a portion of their route, and faithfully following them in others. Weismann, Darwin, Palmèn and others, believe that these routes are older than the present topographical conditions, that what is now sea[1] was land in a past geological age, furnishing way stations of food just as the littoral and fluvial routes do at the present time.

The study of route migration emphasizes two things, (1) that the migrating impulse is, at least, partly inherited. (2) That its antiquity dates back to former geological periods. It has also directed the attention of the movements of single species, and given hints on the relation of bird movements to food, but it does not account for the *origin* of the vast movements. Allen,[2] Spencer,[3] Darwin[4] and others say in substance, that the instinct grew out of a series of freezings and thawings of the glacial epochs, that bird life must have been crowded southward, and the struggle for life thereby greatly intensified. The less yielding forms may have become extinct ; those less sensitive to climatic changes would seek to extend their range by a slight removal northward during the middle intervals of summer, only, however, to be forced back again by the recurrence of winter. These incipient migrations must have been gradually extended and strengthened as the cold wave receded, and opened up a wider area within which existence in summer became possible. What was at first a forced migration would become habitual, and through the heredity of habit give rise to

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[1] This may be illustrated by the route taken by the crane and eiderduck from the mouth of the river Rhone to the shores of Africa. Instead of striking directly across the sea from the Rhone, they pass along the west coast of Italy, via Sicily, and from thence to Africa. It is pretty well established that the Mediterranean Sea was divided into two halves by an isthmus between Sicily and Africa, which birds followed in their migration north and south. This strip of land began to sink gradually, the flat places becoming bogs, and later so many little straits, the higher places would form a chain of islands, Sicily being the last surviving link in the chain. These bogs and islands instead of inducing the birds to change their course would, if anything, rather tend to strengthen their preference for it on account of the variety and quantity of food furnished by such land forms. So that by the time of a complete submergence the inherited tendency for this particular route would have become so strong that it impelled them to cross this vast sheet of water.

[2] Allen, A. J.: Scribner's Month., Vol. XXII, pp. 932-938, 1881 ; also Bulletin, Nuttall Ornith. Club, Vol. V, 1880.

[3] Spencer: Prin. Biology, p. 412.

[4] Darwin : Origin of Species, p. 342.

the instinct. Temperature and food are the principal factors in this theory.

The metabolism of the bird exceeds that of all other vertebrates. This calls for abundant and nutritious food, and especially during the breeding season. So vital is this relation that Wallace is disposed to regard the migrating instinct—" as[1] an exaggeration of a habit common to all locomotive animals of moving about in search of food." Indeed Hudson[2] has found that abundance of food may change the time of the breeding season.

[3] "In the island of Goree the swallows remain through the whole year because the warmth of the climate enables them to find food at all seasons." Allen[4] has shown that the distance traversed by the migratory kind in passing from their summer to their winter homes is in direct relation to their habits in respect to food. Yet while the effect of food upon bird life is direct and vital, it does not explain satisfactorily the periodicity of the impulse, the regularity to a day with which some birds return to their nesting places. In fact it does not account in many cases for the southward movements. The swift[5] and cuckoo both in America and England leave for the South when nature is in her richest abundance and the temperature fairly constant. Many birds leave their winter homes in the tropics in the height of the tropical spring when insect and vegetable food are daily increasing. They leave a land of plenty for one from which the snows of winter have barely disappeared, often coming so early that unseasonable weather forces them to retreat.

This advancing, checking, stopping suddenly or even retreating temporarily led Prof. Cooke[6] to study the relation between meteorology and migration. His extensive data suggests a correlation between successive "bird wave" or "migration wave" and the "warm waves" in the atmosphere. The investigation was not a complete one and is doubtless subject to errors and corrections.[7]

It seems clear in some cases that temperature exerts a direct influence upon their movements, but it sheds no light upon those very definite migrations that occur in equable temperature and abundance of food, e. g., swift, cuckoo, bobolink. Many East-

[1] Wallace, A. R.: *loc. cit.*, p. 21.

[2] Hudson, W., H.: *loc. cit.*, p. 63.

[3] Ribot, Th.: Heredity, p. 16.

[4] Allen, A. J.: Scribner's Month., *loc. cit.*

[5] Couch : *loc. cit.*, p. 138.

[6] Cooke, W. W.: Report on Bird Migration in the Miss. Valley, 1884-85.

[7] A further attempt has been made to represent graphically the migration of birds and the composition of the avi-fauna changing with the season. W. W. Stone, The Auk, Vol. VI, p. 139.

ern species move southward not according to temperature
changes, but rather with respect to food changes.[1] Wallace
and Chapman contribute evidence showing that temperature
and weather elements in general have very little to do with the
time of their arrival or departure. They consider temperature
effective only as far as it effects food supply. The Pine War-
bler's wide area (16 degrees parallel of latitude) of nidification is
a case in point showing that temperature alone is not the factor
that determines bird distribution and migration. Again, if
food and climatic elements were the sole factors in originating
the impulse, the periodic migrations within the tropics would
remain mysterious, because, there, these factors are compara-
tively uniform throughout the year.

Physiogenetic. I think it quite probable, that, if a careful
record of a bird's metabolism were kept throughout the year,
and expressed graphically, it would show among other things
two distinct evelvations, a large one at the approach and during
the reprodutive period, and a smaller one at the moulting sea-
son. Facts are not wanting which lend this supposition some
degree of certainty.

It is well known that both physiological and mental changes
more or less varied, occur in nearly all species from crustaceans
to and including species of anthropoid apes, during the pro-
creative period. Darwin[2] in his thesis of sexual selection pre-
sents an immense number of facts on this point, especially on
the changes that occur in secondary sexual characteristics.
These changes reach their climax in birds. The voice, plumage,
comb, wattles and weapons of various sorts are all brought to
their greatest possible perfection. These secondary sexual
changes are paralleled by more fundamental and important
ones in the primary organs before their flight. In[3] the case of
sea birds dissection shows an enlargement of the sexual organs
before their flight — those of the male enlarge first. The deposit
of eggs by the trout and salmon soon after their arrival to the
spawning areas is evidence of ovarian activity even before migra-
tion began. The parturition[4] of the seal occurs within a day
or two after her advent to the rookery. Stork,[5] geese, and
members of the Hirundinae[6] family display unusual activity
previous to their flight.

These periodic "self-assertions" of the reproductive energy
induce physico-chemical changes throughout the whole organ-

[1] Newton, Prof.: See article in Ency. Britannica.
[2] Dawin: The Descent of Man, pp. 270-555.
[3] Chapman, F. M.: The Auk, Vol. XI, 1894, pp. 12-17.
[4] Elliot, H. W.: An Arctic Province, p. 282.
[5] Swainson: *loc. cit.*, p. 261.
[6] Cauch: *loc. cit.*, p. 130.

ism, thereby ill-adjusting it to external conditions which before favored and promoted well-being. Influenced by this new development of organs and energy their very nature seems altered ; and while the climate they formerly delighted in has thus grown irritating and irksome, they feel a craving for one in which the procreative impulse may best be carried into effect. Similarly, the "moulting season" works physiological changes of the greatest importance for the individual. If the physico-chemical changes of the procreative period are in the interests of the species, the race, those of the moulting season are for the individual. During this season hens cease to lay, birds quit singing. Naturalists speak of them as "moping." Peafowls hide, courting and love antics cease. Rich[1] food and excited antics are requisite to the moulting process. "This feverish condition is accompanied with a higher degree of sensibility, which renders irksome and aggravating those impressions of the air which before were pleasing. An appetite for new kinds of food may be a natural accompaniment of this state of the body. The moulting process, *per se*, occurs in migratory birds as soon as they complete their southward journey. These considerations point strongly to the conclusion that both the *homeward* and *outward* migrations have a physiological basis, and that these processes serve as a stimulus to the nervous mechanism which discharges in terms, so to speak, of migrations. There are also two other motives associated with the breeding seasons that set in motion almost all forms of life. The first includes all those activities connoted by "sexual selection," the second is the search for suitable breeding areas.

Animals, which are at all other times solitary, including most carnivora, seek the opposite sex of their species during the rutting season. The lion, tiger and the entire family of Felidæ, both wild and domestic, lead solitary, selfish, vegetative lives, except during the season of love. The sexes of the arctic reindeer keep apart except at the courting season. The same is true of the wild turkey,[2] the grouse, and certain vultures of the U. S. The male chaffinches in Sweden never migrate. The females go south in September and return to Sweden in April, where they are fought for to the finish by the males. Pairing, according to Darwin, is effected by the "law of battle." Describing it among birds, he says, "when many males congregate at the same *appointed spot* and fight together, as in the case of grouse and various other birds, they are generally attended by the females which afterwards pair with the victorious combatants." The point urged here is that the desire

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[1] Brehm, Dr. A. E.: Bird Life, p. 372.
[2] Darwin : Descent of Man, p. 416, etc.

for a mate or mates brings together periodically great aggre-
gations of life, that otherwise would have met perhaps by
chance.   May not the desire for a mate and the repeated bodily
experiences excited in what was at first accidental meetings
and pairings have become permanently associated, so that the
desire for a mate is immediately followed by a journey for one,
or to the "breeding ground?"

The search for suitable breeding areas, it appears, is prompted
by two causes : first, suitable food and shelter for the young ;
second, the well known desire that so many animals have for
seclusion during the reproductive period.   In fact nearly every
species of the great backboned series will seek at the approach
of this season some retired part of their haunts or range in
which to bring forth their young.   Probably the second desire
grew out of the first, especially out of the necessity for shelter
for nest, eggs and helpless young.

The female of the reindeer[1] of Norway, of the common stag[2],
of the long-tailed deer of the British Isles, of several species of
[3]monkey[4] isolates herself from her congeners and other forms
of life for a fortnight or more during parturition.   The annual[5]
return of the seal to her "rookery," at the breeding season is
absolutely necessary for the perpetuation of the species.   The
young seal from the moment of birth to a month or six weeks
is utterly unable to swim.   Especially is it necessary that birds
should select safe breeding grounds, nests, eggs and birdlings
are fragile, helpless objects, an easy and tempting prey to ene-
mies.   There is no wonder to be attached, then, to the fact that
birds above all other creatures are most circumspect[6] about the
location of their breeding sites.

In England the chaffinches and a host of other birds spend
the winter in the open country but at the approach of spring
come to the gardens, hedgerows and fruit trees because these
places offer better security for nesting than the wood or heath.
The starling spreads itself over the country of Cornwall in the
winter and in the spring immense flocks desert their food area,
though only to proceed to the distance of a few miles, for the
sake of a place in which to hide their nests.   Chapman men-
tions several species of tropical sea birds that resort each year
to some rocky islet, "rookery," where they may nest in safety.

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[1] Darwin : The Descent of Man, p. 503.
[2] Swainson : *loc. cit.*, p. 275.
[3] Hartman : Anthropoid Apes, pp. 247-48.
[4] Heape, W.: Philo. Trans., Part I, p. 413, 1894.
[5] Elliot, H. W.: *loc. cit.*, p. 287.
[6] It is not to be understood that birds are conscious of the superior
advantages of these sites any more than they are conscious of the fit-
ness of the materials (grasses, hair, sticks or mud) used in nest build-
ing.

These movements are usually regarded as non-migratory, and yet the object is the same, and the migration as regular as that which prompts a wagtail or a puffin to wing its way from the Mediterranean to the arctic regions.

[1] Brehm says : "The act of migration stands in a certain way connected with the business of breeding and moult." [2] Wallace has emphasized the necessity of separating the *subsistence* and *breeding* areas making food and safety during the nesting period the causal elements or initiative factors.

These two authors, taken together, correlate the reproductive and moulting processes and the instinct for seclusion with that of migration. To cover the facts of *periodicity*, of all real migrations, the immense *distance*, and *direction* of some of the routes, I should restate and add to the above theories in somewhat this fashion : *The incipient factors in originating the migrating instinct are the* COINCIDENCES *of the physico-chemical changes* and the *instinctive desire* for *seclusion and* for *suitable breeding areas with the periodicity of the seasons.* If it had happened that secluded and suitable pairing and breeding grounds had always been selected in an east and west line from their area of "subsistence," it is probable that the powerful instinct as we know it, would never have originated, because the *climatic* and food elements could never have co-operated with the procreative factors ; on the other hand it appears as equally improbable that the instinct should have originated in the absence of the desire for seclusion or suitable breeding grounds or the ever recurring physiological changes which mark the annual cycle of bird life. [3]

This theory explains a number of facts connected with bird migration that are otherwise mysterious.

Males of many species precede the females in the northward journey ; this correlates with the male sexual organs developing first. Birds that do not sexually mature the first year in the feeding area either migrate only a small portion of the way or not all. Barren birds of a migratory species remain south all their lives, only at times do they make a portion of the journey—doubtless due to imitation and the social instinct.

[1] Brehm, Dr. A. E. : *loc. cit.*, p. 368.

[2] Wallace, A. R. : Nature, Vol. X, 1874, p. 459.

[3] Chapman says—in the Auk, Vol. XI, 1894—"It is not improbable that the period of reproduction may have been coincident with the return of the warmer part of the year and in addition to the desire for seclusion and the pressure exerted by the crowded conditions of existence, which then prevailed (during glacial epoch), was potent in inducing birds to seek breeding grounds in the north during the summer. The only criticism offered against this theory is the time (glacial period) and the place (northern zones) it offers for the origin of the instinct. Arboreal tropical life is now believed by naturalists to be the natal home of birds.

The arrival to the breeding ground is much more regular and uniform than their departure, the latter is usually governed by the success of breeding. They come burdened with the great task of procreation which gives instinctive purpose and precision to their movements, they leave in obedience to vegetative functions. The theory accounts for their leaving breeding or feeding area when to all appearances temperature and food are ideal.

LOWER MAMMALS. Omitting the voluminous literature on this topic I shall mention only briefly the more significant facts.

Movements to which the term migration is applicable are seen in ten or twelve species of rodents, certain wolves and bears, several species of rengulate and a few primates.

Classical examples of the instinct among rodents are the military-like advances of the squirrel, the hare and notably those of the lemming.[1] The movements begin in the spring or fall and may continue during severe weather. The object is apparently to enlarge their food area which is made necessary by an unusual multiplication [2] of the species and an unfavorable food season.[3] "Wolves[4] everywhere descend from the mountains to the lowlands in severe weather, and bears not infrequently migrate in great numbers to escape the rigors of an extreme winter.

Porcupines in Persia migrate north and south with the seasonal changes of temperature.

Reindeer and antelope, especially the latter, migrate in some countries as regularly as the fishes and birds,—the females of some species going farther north than the males.

Food, enemies and change of seasons influence the movements of monkeys.

On the whole it appears that, although the movements of the lower mammals are due to the same causes that control animals moving in air or in water, yet they are less precise, definite and periodical. True, unmistakable traces of the instinct are present, manifesting itself in flashes, as it were, sometimes impelling the creatures to distruction, *e. g.*, mouse and lemming.

Domestic Animals.[5]

For the sake of completeness, but more particularly for emphasizing certain observations made in the present section and

[1] Romanes: Mental Evolution in Animals, p. 282.
[2] Swainson: *loc. cit.*, p. 250.
[3] Heilprin: Distribution of Animals, p. 40.
[4] Wallace, A. R.: *loc. cit.*, p. 18.
[5] The material presented here is in answer to Rubric XIII of the syllabus. Two hundred and fifty cases were received on ducks, turkeys, chickens, cats, sheep, cows, horses, etc.
Doubtless they will seem very commonplace, so they are, but to

by way of introductory to the love of home, I treat here the migrating and homing phenomena of domestic animals.

FOWLS. 1. "I have observed that animals, such as cats, dogs, hens, hare, cows and horses are attracted to home life, while fish, ducks, turkeys and guineas are not—they like to wander."

2. "Our chickens often wander but are sure to return before night fall, while our turkeys always wander away, and sometimes they stay."

3. "Have known hens and turkeys to stay away during the day and lay their eggs in the fields or woods and come home at night."

4. "A neighbor had a hen that would come *to our place to roost* but always *went home to lay.*"

5. "When we kept turkeys they used to wander from home; especially to build nests."

6. "When a hen 'stole her nest,' we found it hard to locate it, because the hen would not go to it when any one was looking."

7. "Have known Mrs. C. to watch her turkeys for two hours at a time to find where they laid. She was often compelled to follow them over a mile away into some underbrush."

The writer has performed the very monotonous juvenile task of following the wanderings of a turkey-hen until she saw fit "to take" her nest. If she detected my watching, her course was most often turned leisurely in the opposite direction, and she would postpone going on for several hours; sometimes, if watched too closely, she would not visit the nest that day. Usually when she "made up her mind" to go, she struck a bee-line for the nest as fast as she could run.

8. "Had given up one of my hens as stolen or killed, when to my surprise one day she entered the yard and presented me a dozen little chicks in a very 'fussy fashion.'"

9. "Have a number of times missed hens and gave them up for lost, but after some time they would come up with a few little chicks."

10. "We gave up keeping turkeys because it was impossible to keep them at home."

11. "It was very hard to keep ducks on the farm, although we had a brook and pond; they were forever gone,—would wander a mile or two below the house staying two or three days, when back they would come—as soon as fed and rested a day, away they would go again."

12. " . . . . Sold a couple of ducks to a neighbor three miles away. About a week after a tremendous noise in the yard awoke the household. It proved to be the quacking and gabbling of the ducks. Never before had I seen an animal make so great a display of pleasure."

13. " . . . Drove my young chicks over a week old at evening into a new coop, but left the door open until late, as it was a very warm night. When I returned to shut the door of the new coop, they had all left.

the writer therein lies their value. The näive innocence, simple-mindedness and freshness with which they are told precludes all suspicion that their observations were influenced by preconceived theories and biological conceptions as to the deeper significance of what they saw.

Going to the old one I found them all cuddled in a heap beside the closed door." [1]

CATS. 14. "My cat goes away frequently, stays three or four days perhaps—always glad to see us on his return."

15. "Our cat goes off for two or three days, and then returns. He is treated kindly and well fed, but just roams off, we can expect him within a week."

16. " . . . This cat used to go away every month, and stay about a week, then come back. Its journeys were regular."

17. " . . . Owned a cat that would stay in the woods for three months at a time, she would then return home with four or five kittens."

18. "Had a cat that would take care of her little kittens in an old basket at the next door neighbor's. She brought her kittens over home three times a day to be fed."

19. "When the little kitten of our old cat got big enough to run around we used to play with it a great deal. One day it disappeared. Thorough searching proved in vain. The old cat was around every day, but no kitten. One day the old cat was spied going across the field. I followed. She led me across two large fields to a patch of oats. Went to the edge of them and called. Out came that little kitten as fat as a butter ball. We think the mother hid it because we fondled it too much."

The last six cases are typical of 36 that illustrate a role by the procreative factor in wandering.

20. "Have observed that cats had much rather have one place in which to sleep."

21. "Cats will seldom leave permanently their old home, even after the family has moved away."

22. "When we moved into our new house we left behind a large cat that had been in the family for several years. My father was very fond of the cat. He would go down to the old house with food for the cat, but he would not eat. He howled day and night, but whenever any of us went down to the old place he would jump on us, roll over and purr, and act wildly glad. My father could not bear the idea of its grieving and starving itself to death, so the cat was brought to the new home. He was crazy with joy. He ran up and down stairs, on top of the furniture, rubbed against and smelt of everything, climbed up on us, walking right up our skirts into our arms, remaining but a moment, then down again, and following us about like a dog. After awhile he settled down and went to sleep."

Fifty cases like the last five were received on the home instinct of the cat.

DOGS. The following cases are typical of the wandering and homing instincts of dogs :

23. "Our dog went back to his old home, three miles distant, every Saturday night, and returned every Monday morning regularly."

24. "Owned a dog that was very fond of going off on long journeys by himself. Sometimes he would be gone two or three days, and would come home worn out and in every way ready for rest. After he had stayed home several days he would be ready to start out again."

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[1] I have before me numerous observations on the homing of pigeons, but such facts are every-day occurrences, as observations and current literature abundantly testify. The cases are therefore omitted.

25. "Had a dog that would travel a week, then stay at home a week, until finally he disappeared."

26. "Have a dog that persists in running away. Is kept tied, will leave home as soon as untied to go to where there is a dog. He will not go away during the winter."

27. "Know a dog that spends a great part of his time at a neighbor's, although his master is good to him."

28. "Dogs will often go off on journeys lasting two or three days or longer, but will return after that time."

29. "Brother bought a hound from an old man living some miles from our home. The dog returned next day. We went after him a number of times. Even after the old man died the dog would make trips to his old home."

30. "My parents owned a fine setter. They sent him to a farm forty miles away, to be trained. On taking him from the wagon when the farmer reached home, he got away and came home. He ran right up stairs into a room where my mother lay sick, putting his forefeet on her bed. . . . . He was not to be driven from her bedside that night."

31. "A member of my family was a witness to the following incident: A farmer living near North Bend on the Ohio, transported his farm products on a flatboat down to Vicksburg. On one of these trips he took a highly prized dog. At the landing place at Vicksburg the dog disappeared. About a month after the owner had returned the dog came home poor and half-starved. He had travelled hundreds of miles, swam rivers, threaded forests, forded swamps and faced starvation to return to his home."

SHEEP. 32. "Flock of sheep in the spring have started about the usual time for the range where the older ones of the flock had pastured for two or three years. The pastures were on high hills, and the warmth and dampness of spring may have produced a degree of discomfort that reminded the sheep of the fresh pastures, breezes and hillside springs, where, shorn of their fleeces, they had enjoyed previous summers."

COWS. 33. "A man in our neighborhood has a cow that runs away from home. She will be gone for a day or more, and then will come back again."

34. "Our cow had spells of going away every month last summer."

35. "Mr. C. had a cow that would leave home every chance she could get, and would go into the country. Sometimes found ten miles away from home."

36. "A cow that will make her escape from pasture and return home, at a distance of several miles, at every opportunity."

37. "A herd of young cattle belonging to my grandfather escaped from a wild pasture about the last of September, and came home, a distance of twelve miles."

38. "Sold a cow to a man living about twenty-five miles away over rough hills and streams. She came back in a few days and stood by the gate until we let her in. She was again taken to her owner, but soon returned. It was very cold weather. We drove her away and made her stay outside of shelter, but without avail. Fearing she would die of hunger and cold we bought her back."

HORSES. 39. "Horses always come toward home faster. Have known very few to wander away from home."

40. "Horses become attached to home if it is one in which they are treated kindly. Know a horse raised and owned by one man until the horse was quite old. He was then sold to a person who kept

him, not far from his former home, but the horse was so homesick
that he refused food and water, and would immediately start for home
on being released.   He was not allowed to return to his old home
and consequently died of homesickness."

41.   " Have known dogs, horses and cows, to suffer so intensely
from evident homesickness, and so little food did they eat that great
weakness and emaciation resulted.   The diagnosis was confirmed by
allowing such animals to be taken to their homes, when appetite and
health promptly returned."

42.   " Horses and cows will often wander in search of more or bet-
ter food, but will soon return."

These cases indicate sufficiently the causal efficacy of food
(case 42), temperature and seasons (32), in impelling domesti-
cate creatures to wander ; and likewise emphasize strongly
that the procreative processes ill-adjust periodically, the organ-
ism to its home, and further, that along with these physiologi-
cal changes are co-operating the instinctive desires for pairing
and seclusion during the periods of nest-building, laying
(cases 4, 5 and 6, etc.), parturition.   In some cases the whole
periods of gestation is one of seclusion (case 17).   Cats, dogs,
cows, and even horses will often hide their young (case 19),
especially if one fondles or pays them considerable attention in
any way.   The many advantages derived by seclusion from
members of their own and those of other species during this whole
period are self-evident.   A hen will lay in the woods, and
come home to roost and feed.   A cat will keep her kittens in a
basket at the next neighbor's barn, but brings them home
three times a day for meals, a cow nurses and conceals her
calf in a thick copse, but pastures in the open field.   Thus
domestic animals, like the birds, often make an effort to sep-
arate the reproductive from the vegetative areas even during
and after the period of gestation.

The periods of heat in the cat, dog and cow, are coincident
with their leaving home.   Doubtless the horse would prove no
exception if he were allowed equal freedom.   It appears that
the periodical physiological changes of the sexual organs com-
pletely overpower whatever adjustment the organism may have
effected on a vegetative basis, and impels it to seek forces that
will restore its equilibrium.   Good food, comfortable quarters
and kind treatment (case 27) are no longer attractive.   The
male of both the feline and canine races leave their comforta-
ble vegetative quarters to become the paramour of a female of
their respective species, and this too in the face of repeated bit-
ter experiences, strength challenged on every hand, deadly
combats waged with other male suitors, many a kick and cuff
delivered by man, and of privations and hunger continually
besetting them.

The appreciation and love for home in domestic animals is
wide spread and oftentimes very intense and pathetically ex-

pressed. A new cot, a new kennel, a new manger of strange smells and sights, a new master with new and strange methods of treatment produce at times acute cases of nostalgia in dogs, cats and horses.

The observations of this section indicate that temperature is the chief cause in the majority of fish movements, likewise of lobster and a few mammals, as squirrels, monkeys and porcupines. In so far as it affects the food supply it may be regarded as an indirect cause among all species. Food and atmospheric pressure seem to be the dominant forces among many insects, *e. g.*, locusts, grasshoppers, etc. The procreative instinct is operative in all the species considered save the lobster, and probably the locust. With certain land crabs, butterflies, fish and eels, all birds, many rodents and the wandering of all domestic animals, the procreative instinct, I am persuaded, is paramount.

No one factor acting alone is responsible for the instinct. It is the product of a nexus of forces co-operating and supplementing each other. But when the relative *intensities* of the many factors are considered, together with the circumstances and the order in which they operate, it appears that the procreative instinct is the initiative, the primal factor, and that cosmic forces give precision, definiteness, and periodicity to its expression.

SECTION B.

Migrations of Primitive Man. The present section is concerned with the wanderings of primitive man, to the end of exposing in rough outline the customs, habits and characters of a migrating people. The conception of the migrating instinct thus seen in the race may improve our position for interpreting the instinct as expressed by the individual.

Ethnologists,[1] generally, subscribe to the assumption that man must have begun his career on some fertile island[2] or region in the tropics.[3] While here his food consisted of the fruits and herbs of the forest. He was a frugiferous animal. Increase in his numbers soon forced him to migrate into regions less secure and blessed with a less genial climate. These forced movements compelled him to face a host of new conditions, *e.g.*, new climate, new food and a new array of enemies. As he migrated farther and farther away from the tropics the food supply came gradually to be seasonal instead of perennial. To secure food during the interim of the fruit bearing season he drew on the lakes and rivers for *fish*—his first artificial food.

[1] Morgan, Lewis H. : Ancient Society, p. 20.
[2] Lyell, Sir Charles : Antiquity of Man, p. 433.
[3] Mason, O. T. : Migration and the Food Quest. The Amer. Anthropologist, Vol. II, No. 3, 1894.

They " were universal in distribution, unlimited in supply and the only kind of food at all times attainable.

It is quite probable, too, that after coming within range of seasonal changes his dependence upon stream and forest for food compelled him to migrate back and forth to some extent with the seasons."

[1] Brinton says : " These periodical journeys extend hundreds of miles and embrace the whole tribe.   This must also have been the case with primeval man when he occupied the world in paleolithic times.   His home was along the shores of seas and the banks of streams.   Up and down these natural highways he pursued his wanderings until he had extended his roamings over most of the habitable land."   [2] Such is the case among modern primitive peoples who control as yet but few of the forces of nature.[3]   While fish food rendered man to some extent independent of climate and locality he was forced to limit his excursions along sea shores and river courses until he had acquired sufficient skill with bow and arrow to kill his prey at a distance.   Skill with these implements permitted distant excursions into the forest ; fruit and fishing areas might now be deserted at a less risk of perishing from hunger.   The chase became the highest of arts, the strongest incentive to wandering in all probability that man has ever received.

These three stages, the *frugivorous*, *fishing* and *hunting* furnished admirable conditions for the origin and growth of the *wanderlust* spirit.   Their periods were *long* and the stimulus *intense*.   There is much evidence from geology and paleontology showing that these periods may count their years by tens of thousands, that the transition from the frugivorous man to the nomad is many times longer than from the dawn of history to modern times.   If psychic evolution has at all paralleled structural in point of time, there are strong reasons for believing that man was merely a fruit gatherer longer than a fisherman, a fisherman longer than a hunter, a hunter longer than a nomad and the latter longer than a farmer and homemaker in the modern sense.

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[1] Brinton, G. D. :   *loc. cit.*, p. 74.

[2] Mason sets forth the view that America was accidently settled by some remote ancestors of the red man who left their home in the East Indies in quest of food and crept slowly but surely along the coasts of China, Japan and Aleutian shores until they reached the shores of Western North America.   Likewise Otto Sittig (Smithsonian Report 1895, pp. 519-35) says that the islands of the Pacific were peopled by compulsory migrations.   The frail crafts of the natives of the Malayan Archipelago while in search of fish and other food were accidentally caught by contrary wind and current and carried to more distant islands.

[3] McGee, J. W. :   The Amer. Anthro., Vol. VIII, No. 4. 1895.

Victor Hehn says: "We cannot sufficiently estimate the slowness and difficulty of the transition from a wandering hunter's life to the taming and tending of cattle, nor of that from nomadic freedom to a settled domicile. Necessity must have been very pressing before the shepherd could resolve to dig up his pasture land, to sow grain, to wait for its growing . . .
. and so tie himself down to one spot like a prisoner and a slave. . . . . In the same way the hunter felt cattle breeding a kind of slavery. Armed with bow and arrow . .
. . he freely roamed the woods. . . . . If he had the luck to kill a wild bull, he could feast for days." Hunting must have become unprofitable, indeed, before the less skillful, hampering and humdrum arrangements of cattle tending were resorted to as a means of support.

Among the many factors arguing that man has and is passing through these several stages are those represented (1) in the primitive ways of the Tasmanian, Bushmen, many Indian tribes, Gypsies, Bedouin, and nations of the Mongoloid type; (2) by a large class of individuals in civilized society that neglect home life and throw off responsibility at every angle to become a planomaniac, a globe trotter, a Thoreau, a Robinson Crusoe, or a Captain Kidd; (3) by the atavistic activities of childhood, e. g., fondness for water,[1] tree climbing, hunting trading and bartering, etc.

To get a composite view of the planomaniacal [2] type I quote from one hundred and forty-four cases [3] bearing on that sort of an individual.

1. F., 35. "Leaves home nearly every day immediately after breakfast to go visiting—is discontented and unhappy when compelled to stay at home."

2. F., 48. "On the go from morning till night—sometimes only running to see her nearest neighbor, sometimes going away on the cars—she keeps this up four or five months at a time, then suddenly stops and will not leave her yard for several weeks, nor does she care to receive company during her stay-at-home spells."

3. F. "Married, does not stay at home more than two hours during the day—spends her time in running about. She is young and does not have very much to do, perhaps she gets lonesome."

4. F. "Seems restless, is out calling every day—can't stay at home long at a time, although home and home-life is attractive and pleasant."

5. F., 50. "Married, educated, raised a family who are ignorant through neglect. Kind hearted, picks up and visits for a week, or will wait on the sick for weeks at the neglect of her home duties."

6. F., 30. "Good natured, smart, good cook and yet she allows her little girls to come home from school and prepare their own dinners. She leaves often after breakfast and does not return till bed time. She does not seem to do it to get rid of work, as often she will

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[1] Truancy, *Ped. Sem.*, Vol. V, No. 3, pp. 396-419.
[2] Rubric VIII of Syllabus.
[3] Ninety-five per cent. reported are females.

be helping some one to do just what she has left undone at home."
(Many cases of this kind.)

7. F. "Married, quick and active, will take one child in her arms
and have the others following after. Household duties do not worry
her in the least. She says life is too short to waste it in the house."

8. F., 30. "Has a fixed day to visit each of her friends every week
—can't be found at home more than two days in the week."

9. M., 52. "A comfortable home, good clothes and food, but will
not stay at home. Always finds some news to carry from one place to
another, and *is always ready to eat.*"

10. F. "Has a large family, always on the go in all sorts of
weather, will keep her children out of school to stay with the little
ones. Her calls are of a gossiping-seeking sort." (Five cases of this
nature.)

11. F., 50. "Not interested in the duties of home, neglects them
to go calling, cannot bear to be alone."

12. F. "So fond of calling that she will bring her cooking to our
house. There is no special reason for her doing so."

13. F., 50. "Married, four children, always on the street, or
shopping, will visit the same store several times a day."

14. F., 25. "Unmarried, never satisfied at home, has no taste for
reading or domestic life. Loves to talk and carry news."

15. F. "Always making calls. I think it is to find out other
people's business. Is the first to call on a new neighbor."

16. F., 40. "Always on the street, delights in gathering and
redistributing news." (Cases like the last three are most numerous.)

17. M., 48. "Neglects his family and farm to talk with neighbors,
is fond of trading horses, etc., visits all public gatherings."

18. M., 56. "Had a good farm and well stocked, suddenly
abandoned it to his family, and went calling from neighbor to neighbor.
Fond of children, well read, would work hard for a neighbor, but
would never receive any pay—would only occasionally do a hard
day's work at home."

19. F. "A member of every club and society in which she can gain
a foothold, dips into everything, has done a little of everything, fond
of doing committee work."

20. F., 30. "Neglects home to visit and be with other people.
Good to sick and needy, will do menial work away from home that
she will not do at home. Is fond of going to weddings, funerals, par-
ties, etc."

21. F., 30. "Is noted for going to funerals and public gatherings
of all sorts."

22. F., 40. "Always looking after the needy and sick, a great
church goer, attended all week and Sunday meetings, and all funerals
that she possibly could. Her friends once saw her going to the funeral
of a noted pugilist, though they could not understand how she could
possibly be interested in the deceased."

The funeral and club goers form somewhat a separate group,
yet illustrate the lack of home interests and aversion to static
conditions.

24. M., 22. "Married, seldom at home, fond of horse trading."

[1]The impotency of the home spirit, the desire to lead a semi-
roving life and the attendant psychoses of such a people are

[1] Rubric VI of Syllabus. 217 cases reported, 23% of which were
forced to move because of a failure to pay rent.

further illustrated by people who move frequently. The following are instances of families who move often for some other cause than failure to pay house rent.

25. "A lady and her daughter spend much of their time looking for a new boarding place. They are rich and hard to please."

26. "A farmer, lost a good farm by bad management, has tried several occupations, is discontented, moves every year to a new farm."

27. "M. moves about every two years, always to a different part of the same town. He is always changing his occupation."

28. "Husband indolent with little business ability, wife is ignorant and slovenly, move twice a year. It has come to be a habit."

29. "This family is never contented, think if they could be in some other place all would be well. Within four years they have moved seven or eight times."

30. "This family moves every spring and fall. The man has very poor calculation and generally thinks that if only he were *somewhere else* he might do great things."

31. "This family moves to avoid cleaning house. They endeavor to move into one already cleaned."

32. "This farmer has moved every year for 28 years, moved every spring thinking he would get a better farm."

34. "A lady has moved four times in five years,—although she owns several houses, she lives in a rented one. She is a very restless person."

35. "This family moving into a new place think it delightful and can't praise it enough. They soon grow dissatisfied and move again. They move back and forth from city to country. They are always in an unsettled frame of mind and think they can do better *somewhere else*."

36. "Each time this family moves, they think they are getting a better place. They move every two or three months. They have moved from a house and then back to it again in a few months."

37. "I know many families who move frequently. They always think the new tenement, which may be no better, has some advantage. They do not often get less rent, neither do they leave unpaid rent behind; sometimes they do not even change landlords, nor do they go beyond a radius of a mile for years."

38. "Have known this family for twenty years. They move on the average every six months. They have always lived in the same city, pay their rent — are respectable people. Each time they move they paint, varnish, and paper throughout, build new cupboards and begin cultivating grass and flowers, only to be left in a few months for another neighborhood."

39. "Family of four, all well educated, are continually moving about, from one part of the city to another; they will have a very nice home for about a year, then sell all their furniture and begin boarding. After a short time they become dissatisfied, buy new furniture and go to housekeeping again."

40. "This family is not content to remain long in any one place, grow tired of house and surroundings. They are nice people, much respected."

41. "This family moves about because they never like their neighbors. They usually move two or three times every year."

42. "I know a man with a family of nine, moves from two to five times a year. He is a horse jockey, works but little, loafs around the post office, stores and other places." (Eight cases of this character.)

43. "They move about every four months, are regarded as shift-

less, unstable in character, contented in one place as long as there is
novelty, but soon become discontented and move." (This "shiftless"
class forms 18 % of the number who pay their rent.)

44. "My grandfather would never stay in one house more than six
months. He said he got tired of seeing the same things. They say
he was just the same when a boy, was always changing his room and
rearranging things. As a young man he was always changing his
boarding place."

The planomaniac flees from domestic cares, has no interests
for modern civilized ways, and will not fuse with them. He
could not, if he would, for he belongs (using geological ana-
logues) to a different and earlier formation. We should not
wonder at his dread of solitude (cases 3, 4, 5, 11), at his being
lonely in the midst of modern environment. To such his mind
is vacant, hence his pursuit for diversion, and search for his
kind. Zimmerman[1] says " Vacant souls are always burden-
some to their possessor ; and it is the weight of this burden
that impels them incessantly in the pursuits of dissipation for
relief." How primitive and semi-roving are these traits:
"always ready[2] to eat" (case 9), desire to barter[3] (cases 17,
24), working[4] by fits and starts" (case 18), "shiftless"
cases (cases 28, 42, 43), "slovenly[5] and unkempt in person,"
indifferent to and with seeming inability to fight dirt.[6]

It appears, too, that the desire to rove is not abated with
advancing age, not even with the increase of domestic and
business cares. The cases cited indicate that there are persons
in the midst of all degrees of intelligence and culture that mini-
mize the value of a permanent home, that persist with seem-
ing delight in a roving and nomadic life. Their lives are de-
voted in searching for the new, getting acquainted with the
unfamiliar, gathering and distributing news, and dipping into
new enterprises. They are possessed by a consuming curi-
osity, frequently of the idle sort.

The concomitancy of the roving and curiosity instincts in the
same individual suggests a common origin, if not a causal rela-
tion. The conclusions[7] of naturalists[8] and genetic psychologists[9]
are to the effect that curiosity arose from the hunger and fear

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[1] Zimmerman: Solitude, p. 12.

[2] "These Indians are disposed to gluttonize in idleness, when oppor-
tunity arises, when their power for consuming is no less striking than
their power of abstaining. This characteristic of the tribe is pos-
sessed by other primitive peoples." W. J. McGee, Amer. Anthro.
Vol. VIII, No. 4, 1895.

[3] The Bedouins possessed this trait in a high degree. See Ency. Brit

[4] Ellis Havelock : The Criminal, p. 101.

[5] Lubbock, Sir John : Prehistoric Times, p. 432.

[6] Bancroft, H. H. : Native Races.

[7] Darwin : The Descent of Man, p. 71.

[8] Romanes : Animal Intelligence, p. 279.

[9] James : Psychology, Vol II, p. 429.

instincts. The motives for animals to investigate the unfamiliar, it would seem, are twofold, (1) to see whether or not the object in question is harmful, (2) to see whether or not it is palatable. Likewise the passions for excessive call making, gadding about, "the first to call on a new neighbor," continual shopping (but rarely purchasing), sampling and "sizing up" the material and mental furniture of a newcomer may have originated out of the necessity, common to all organisms, to know what is harmful and friendly, nourishing and distasteful in their *milieu*.

Interwoven with this curiosity plexus of motives, sometimes separated from them, is a longing for the unexpected, moving with the hope, Micawber-like, "That something may turn up," imagining that the other side of the road is always the better. They have an insatiable desire for conjuring with that unknown factor that lurks in the untried, to commit their fortunes to the play of the mysterious and unconscious forces of the universe which to so many lend an irresistible charm to a new game, new neighbors, a new house, a new farm, a new position, a new enterprise. In gambling it is the element of chance, in trading and barter it is termed luck. Hence it is that we find so many of these people doing a shiftless, bartering and gambling business where the conditions of chance and luck have their fullest swing. In all probability these conditions were at their best during the life of the primitive hunter and trapper. Here the degree of probability that labor will be proportionately rewarded is at a minimum. The ratio of reward to labor becomes so infinitely small that he comes to regard his rewards and successes due to chance rather than personal effort. One should not wonder, then, at barbarous and semi-civilized people persistently and continnally creating conditions in which chance is at a maximum. Trapping, hunting and fishing are pursuits that reward more by chance than deliberate effort or certainty. Daily bread is the reward of *one lucky* arrow, spear, trap or net out of a hundred of such instruments and not by the sweat of the brow. The psychology of longing to be in some other place, for new conditions, for speculating, for gambling, is a reassertion of the old associations between chance and reward formed when the welfare of man was largely dependent on the mysterious forces of chance.[1]

Probably the gypsy is the best type of a wandering people

[1] The origin of many forms of gambling, and games of chance and lot as opposed to skill among the Chinese, Koreans, North American Indians and many other primitive tribes, lends considerable support to this theory, in that they all can be traced back to throwing the arrow, or tipped and feathered bamboo reeds as well as species of dice. . . . See Stewart Culin : Korean Games.

who have kept intact the customs and habits that once uni-
versally prevailed.   The gypsy[1] that we know is quite differ-
ent from those of other countries in their manner of getting a
living.   In Egypt they practice the art of serpent charming and
conjuring ; in France and Spain the girls sit as professional
models ; in England we meet Gypsy Methodist preachers, actors,
quack doctors, chimney sweeps, carpenters, factory hands.   In
every land the men are workers in metals, musicians and horse-
jockeys ; are never scientists, barristers, or men of large affairs.
In this country they travel about over the country in light-
running canvass covered wagons, laden with their goods
and chattels.   They subsist by fortune-telling, horse-jockey-
ing, tinkering, sometimes by selling small articles, trading,
gambling, by theft and deception.   They are dirty[2] both in
person and cooking, lazy, fond of drinking and smoking.
They are charmed by gaudy dress and jewelled ornaments.   In
no country have they ever been known to farm.   A few own land
in this country, but they seldom occupy it, preferring the
wagon and highway instead.   They keep both dogs and
horses, being very fond of the latter.   They have deep emo-
tions, enjoy life, are highly imaginative, and extremely fond
of music.

The gait of the gypsy is not jerky, angular, and individual,
but rhythmical, racial, swaying from side to side, generating,
roughly, from the hips up, sections of an inverted cone.   The
negro has a similar gait.   This animal-like motion is due to
the dominance of the fundamental muscles in walking as op-
posed to the finer, accessory muscles that stamp individuality
upon the Caucasian gait.   Prof. Shaler observes that the gypsy
will not follow the sidewalk and brick pavements.   They pre-
fer the middle of the road.

The origin, together with the traits of a wandering people,
have thus far been sought in the vegetative, the food getting
side of man.   There are impulses and irradiations from the
reproductive functions whose significant bearing on the wan-
dering instinct call for consideration.

The evidence furnished by Bancroft,[3] Westermarck,[4] School-

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[1] For an extended account of the probable origin and customs of
gypsies, see histories by C. C. Leland, or George Borrows.
[2] This is not universally true as the following will show, quoted
from a competent observer : "This party of gypsies were scrupu-
lously clean, had lots of silverware, dishes, etc., all of which were as
clean as could be.   The children, too, were cleanly and neatly
dressed."
[3] Bancroft : Native Races, Vol. I, p. 351.
[4] Westermarck : The History of Human Marriage, p. 34.

craft,[1] Hill,[2] Ellis[3] and others, indicate strongly that in one
stage of human evolution an annual pairing season took place
in the spring or early summer months.   Westermarck, after an
exhaustive research on this subject, says : " It is, therefore, a
reasonable presumption that the increase of the sexual instinct
at the end of spring or in the beginning of summer, is a survival
of an ancient pairing season depending upon the same law that
rules in the rest of the animal kingdom."   The evidence of
the preceding section shows that there is an intensity increase
in the human sexual functions during the spring, not yet sup-
pressed by law, religion and social customs.   There is every
reason to believe that pairing was decided by the "law of bat-
tle."   This archaic habit is known in anthropological litera-
ture as *wife capture*.   That this custom was once general, if
not universal, is inferred from the symbols[4] of capture[5] that are
so wide[6] spread among all peoples[7] at the present time.   Sev-
eral mythic legends, as Pluto and Proserpine, Boreas and
Orithya, Theseus and Helen, the Romans and the Sabines have
in all probability their foundation on the custom of systematic
capture of wives among such ancient races.

The desire for, and methods of selecting a mate inaugurates
practically the same activities as are displayed by lower crea-
tures when accomplishing a similar purpose, viz., the "law of
battle " and wandering.   Olaus Magnus[8] represents the tribes
of northern Europe, as continually at war with one another,
either on account of stolen women, or with the object of steal-
ing women.   In Australia the capture of wives is a signal for
war, and as the tribes have little property, except their
weapons and their women, the women are at once the cause of war
and the spoils of victory.   The same is essentially true of the
Bonàks of California, the Tasmanians and Maorians.   The
coin-men of Patagonia make excursions every year at the time
of "red leaf" from the mountains in the north to plunder
Fuegians of their women, dogs and arms.   McLennan thinks
that the modern groomsmen or " best man " is the legitimate
descendant from the early fighting and protecting protege of the
bridegroom.

War waged for any cause whatever, necessarily strengthens

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[1] Schoolcraft : Archives of Aboriginal Knowledge, Vol. II, p. 224.

[2] Hill, A. S.: Nature, Vol. XXXVIII, p. 250.

[3] Ellis, A. B.: Popular Science Monthly, Vol. XXXIX, No. 2, pp. 207-22.

[4] Westermarck : *loc. cit.*, pp. 283-402.

[5] Wood, Edward J.: Wedding Day in all Ages and Countries, 2 vols.

[6] McLennan, J. F.: Studies in Ancient History, Chapters I, II, III, IV, V.

[7] Ellis, A. B.: *loc. cit.*

[8] Quoted from McLennan's Studies in Ancient History, p. 55.

the wandering instinct—the aggressor in pursuit of his prize, and the aggressed exchanging domestic duties for those of defense and regaining losses. Out of such conditions arose the themes of the greatest poems of antiquity, those of Homer and Virgil have made Ulysses and Æneas classic wanderers for all time. Peggotty wandering in search for Emily, Adam Bede's false betrothed tramping the highway in bitter shame and remorse, the untiring search of Evangeline for her lover over an entire primeval continent, St. Elmo's aimless wandering after killing his rival, are all mental creations that do no violence to human nature. Indeed tragedies and romances are most often the cradles of future wanderers.

The art of wife getting attained its most delicate and refined form in the 11th and 12th centuries, as set forth and practiced by the Troubadours and Courts of Love.

So charming and seductive were their lives and methods of wooing, that every nobleman of any merit, many princes of royal blood, and even four kings became ardent devotees. Love was their theme, their Alpha and Omega, music and wandering the methods of its exposition. They write: "It[1] is love that makes me sing." "For sweet love do I labor night and day in the improvement of my lays." "For love sing the birds, and for love sing I." Says Rowbotham : "The leading and characteristic feature in the life of every troubadour was, that he was expected ' to go through the world,'. . ' to go from court to court.' At the *first breath of spring* (italics mine) the troubadour mounted on his steed . . . sallied out in quest of listeners, and prepared to indulge in what adventure might befall him on the way."

That the activities and attendant passions of (1) the annual pairing seasons, (2) of wife capture in its various forms and consequent wars, (3) of the various forms of symbolism of wife capture and (4) of the ever recurring romantic episodes among civilized peoples everywhere, have impressed the human soul, and have differentiated it in a special way is highly probable. The product of this differentiation is the instinct that impels man to desert home and vegetative stores and seek a world where the procreative functions and its higher irradiations may assert themselves. It would be absurd to interpret the precocious runaways of adolescence, the roving life of many individuals or the life of the vagrant as a direct expression of the procreative functions seeking conditions for satisfaction as witnessed in wild and domestic animals. Scott[2] has argued that these fundamental passions may be irradiated, long-circuited or trans-

[1] Rowbotham, J. Frederick : The Troubadours and Courts of Love, p. 226.
[2] Scott : Sex and Art, *Amer. Jour. of Psy.*, Vol. VII, pp. 153-226.

posed into a hierarcy of activities ranging all the way from the gross sensuous impulse of a marauder to the idealistic sentiments of youth that urges him to go forth espousing freedom's cause, waging war to reclaim a holy shrine, or to a missionary in any good work. Between these two extremes may be mentioned passions to start life, seeking wider liberties, for adventure, yearning for space, for solitude and the like.

The impulse to go off at the approach of the menstrual[1] period, the desire for seclusion during parturition,[2] and the passion for a wedding tour can only be mentioned here as subjects for investigation. No adequate data exists on this phase of the subject.

Historical Migrations. This subject presents three items of interest, (1) the degree of civilization of a migrating nation en masse, (2) the direction of the route, (3) the climatic conditions of the country from which the nations move, and of that to which they go. The organization of a migrating people has usually been of a comparatively high[3] state. They have been skilled in the several arts of war, in making and using weapons, and in handling great bodies of men. According to Von Hellwald[4] the direction of the migratory streams will be found always to lie in the axis of the greatest longitudinal extension of the continent. The historical migrations[5] in the old world have been from the high plateaus of Eurasia in the east to the narrow land areas in the west. In America they have proceeded from the broad land areas of the north to the mild tapering peninsula of the south. Doubtless the mountain ranges that lie in the long axes of continents determine to some extent the direction. Both the temperature and wind of large water areas are more uniform than that of great land areas. Countries, therefore, wholly or partially surrounded by water areas, or that are so situated as to have their shores bathed by strong sea currents, and their surfaces blown over by winds coming from large sea areas, enjoy the most delightful climates in the world.[6] The countries along the shores of the Mediterranean Sea, south-

[1] The writer is informed by a student of psychology that his wife when a girl in her teens at home and at college experienced a vague impulse " to go off," not to hide specially, but to be alone, a few days before each monthly flow. Several girls of her intimate acquaintance professed to her a like experience.

[2] When the time of a Schoshone woman's confinement draws near, she retires to some secluded place, brings forth unassisted, and remains there *alone* for about a month. Bancroft:' Native Races, Vol. I, p. 437.

[3] Lubbock, Sir John: *loc. cit.*, p. 586.

[4] Von Hellwald, Frederick: The American Migrations, Smithsonian Report, 1866, pp. 328-45.

[5] Cram's Universal Atlas, p. 269, 1893.

[6] Davis, W. M.: Elementary Meteorology, p. 338, 1894.

ern California, portions of Chili, etc., are freed from extremes of temperature, winds, and floods and frequent undulations of atmospheric pressures. England, East China and Japan are lands whose climates, though in the great land areas or just adjacent to them, are tempered and uniformed by sea winds and currents. In such countries, *e. g.*, Egypt, Japan, East China, Greece and Rome, are found the oldest and most permanent institutions of man. In them civilization was cradled and wrought out the deeds that form the bulk of history.

On the other hand the great land areas of the N. temperate zones are characterized by wide annual ranges of temperature, in some regions long drouths followed by short but heavy rainfall, and by a wide spread and frequent undulations in atmospheric pressure.[1] Such climates are found on the eastern and southern shores of the Baltic, the northern lands of Russia, northern and central Asia, and the large interior of North America stretching north of the Missouri and northwest of the Great Lakes. The Steppes of Turkestan, the great desert of Gobi and Takla-Makin[2] with moving dunes of sand, portions of Arabia and Persia are all dry lands with a relative large range of temperature.

The uncertain changeable geographico-climatic conditions of these land areas, it seems, would foster and emphasize the several migrating traits already surveyed, would furnish just the right stimuli to set agoing from time to time the old migrating instinct implanted in the race in prehistoric times. Such lands cradled the Tartar, the Hun, Visigoth, Vandals, the Bedouin— the children of want and hard circumstances, the hardy, brawny, restless races, in whose blood there is a good mixture of iron, and which have come forth *periodically* to destroy the luxurious and the wealthy,[3] to lay in ashes the arts and culture that flourish where the forces of nature are more uniform and less rigorous. At the present time, according to Tarde[4] and Below, the life of the pastoral people in the Sahara, as on the plateau of central Asia, is passed in circular migrations, returning to their points of departure. He thinks that caravan life, like sea life, has incited others to a roving life through *imitation*. Commerce conducted in any form whatever, as caravans, railways or ships, is a powerful stimulus to wander-

[1] For physiological effects of elevated climates, frequent undulations in atmospheric pressure, etc., see Hand-book of Medical Climatology, p. 61, by Dr. S. Edwin Sully, also Warren P. Lombard in *Amer. Jour. Psy.*, Vol. I, pp. 5-71.
[2] Heden, Dr. Sven: McClure's Magazine, Dec., '97. "It was all sand-moving dunes of sand. The days were very hot, the nights were bitterly cold. The air was full of dust."
[3] Holworth, Sir H. H.: History of Monguls, Chap's II and III, Part I.
[4] Tarde, M. G.: Revue Scientifique, Vol. XLV, p. 747, 1890.

ing. The tenacity with which trainmen cling to the railroad, the stolid backwardness shown by the Mississippi River steamboat employees to quit boat life and enter other pursuits, are instances justifying Tarde's conclusions. A commercial people are cosmopolitan—rarely if ever homesick. It would seem that certain occupation predispose to restlessness and roving.

TABLE III.

Showing the relation between the age and the manner and causes for leaving home.

Age	Male	Female	No. totals	Injured feelings. No.	%	Love of adventure. No.	%	Love of nature. No.	%	To start life. No.	%	Impulsive. No.	%	Planned. No.	%	Loneliness. No.	%	To see opposite sex. No.	%
1	2	3	5									5	100						
2	6	5	11									11	100						
3	17	9	26	3	13							20	77			12	46		
4	15	8	23	4	11							19	82	4	15	10	43		
5	19	6	34	4	16			3	11			27	79	7	17	12	35		
6	13	5	24	4	12	4	16	3	13			14	58	8	20	6	25		
7	18	11	25	3	12	6	19	4	11			12	48	9	33	4	16		
8	26	7	31	4	13	7	27	8	33	1	4	12	38	11	36	5	16		
9	18	5	26	5	19	17	44	6	24	3	3	11	42	14	35	4	15		
10	32	8	38	10	24	6	42	12	38	3	11	19	52	14	54	0	0		
11	11	6	14	4	28	14	42	7	26	4	10	11	78	3	36	2	14		
12	28	3	34	11	32	20	41	12	31	1	7	16	47	15	21	2	5	1	2
13	38	6	41	9	21	20	48	4	27	4	11	15	36	22	44	3	7	2	4
14	44	8	43	8	26	22	46	4	12	9	21	16	37	25	53			4	7
15	26	5	52	4	22	16	42	4	12	8	18	18	36	29	58			4	13
16	12	8	30	3	17	29	53	2	9	10	30	8	26	20	66			3	16
17	5	4	18	1	12	8	50	2	7	9	22	5	27	11	61			4	23
18	7	6	17			8	47	2	6	4	29	3	17	12	70			2	25
19		2	8			5	62	2	11	5		2	25	6	75				
Total,	380|121		501	104	27	154	30	80	13	61	12	253	50	214	42	60	12	20	4

The Instinct in the Individual. The migratory instinct, together with the comcomitant traits, so far as they can be

made out in childhood and early youth, were treated at some length in my paper on Truancy.[1] It remains to note briefly in the light of all that has preceded the role played by the instinct in maturer[2] life. Our study thus far suggests that its germs are perhaps in every one—at least such is the view here adopted. The instinct is not an anomalous thing. It had a legitimate birth, and is an essential function of the soul. At what age or ages, under what conditions it will most probably control one's activities, and what will be its form of expression, *i. e.*, whether seeking a fortune, love of adventure, or fleeing from restraint, or what not, are suggested from the returns of the questionnaire,—Rubrics I and II.

For total number of cases of runaways, number of each sex, distribution according to age, and the relation between ages and the different causes for running away, see Table III and Chart IV. The manner of running off is partly a function of age (Chart III). All children that run off from one to three do so impulsively.[3] Three to eight years shows a gradual falling in the impulse curve with a rise in the planning curve (Chart III). The child's growing interests and respect for home and parents' and the consequent desire to conceal his misdemeanors are probably factors at work here. From eight to twelve the curves are reversed. This corresponds roughly to the period of slow growth of brain, body, weight and height. It is a time, too, when the child partially slides out from under the sole care and companionship of parents, and sets up a social circle of his own. He is less sensitive and considerate to his parents' reproofs and wishes. Respect weakens, he waxes bold, questions authority. This dare-devil spirit may account for the child doing things impulsively, openly and above board. The ways and manner of leaving home, however, multiply with age. The curves (Charts III and IV) showing the relation between ages and different causes for leaving, are based on too small a number to merit a detailed description; they do, however, emphasize this fact, that childhood and youth are affected differently by the same causes, and further that the causes in-

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[1] Truancy as Related to the Migratory Instinct : *Ped. Sem.*, Vol. V, No. 3, 1898.

[2] It is needless to say that the data for a thorough study is yet to be collected. There is much literature of an idealized sort, descriptive of the professional tramp. But the tramp by no means expresses all of the roving instinct—not all wanderers are tramps. Indeed, if adhering to fixed habits, customs and conditions excludes the roving instinct, then the tramp is not dominated by the migratory impulse, for he is exceedingly staid in all his ways. A study of tramps and vagrants, then, will not suffice our present purpose.

[3] See cases and comment: *Ped. Sem.*, Vol. V, No. 3, pp. 387-90.

crease as the indivividual comes to sustain wider and wider
relations with society.   For example, injured feelings in child-
hood may arise through an unfavorable comparison of their
lot with that of their playmates, and from real bodily wrongs,
or from objective conditions and processes while the feelings
of adolescence are generally disturbed by subjective and imag-
inative conditions.   His moulting ego is excessively sensitive
to personal rights and honor, his good intentions are misin-
terpreted.   The injured feeling curve attains its maximum in
the fifteenth year.   Again, childhood and adolescence are
affected diametrically opposite by solitude.   The former flees
from loneliness, the latter often seeks it.   Childhood goes to
nature (Chart IV) for companionship, adolescence for solitude.

Probably one of the most faithful sources of wandering in
adolescence is restricted liberty, or impatience under restraint.
The following are two cases from more than a hundred bearing
on this point.

1. F., 34. "Until I was twelve, I cannot recall having ever gone from
home with pleasure, but during my early teens I began to feel a sense
of oppression from remaining at home which became highly accentu-
ated by the age of fifteen.   I was then allowed to leave home to teach
a little rural school.   The sense of freedom I experienced was intoxi-
cating (and not mildly).   Yet I was under no real restraint at home.
I simply felt restrained there.   I think I had an irritating desire to
find how I *alone* stood with the world, to feel myself detached from
all that bound me.   During this time I thought much of 'independ-
ence,' delighted in long lonely walks—often pictured to myself the
freedom of the gypsy and delighted greatly in all tales and poems
idealizing the gypsy girl."

2. F. "The noise of a city and the crowds of people always make
me impatient to get away.   I don't like even a day with houses in
front of me— even brown stone, vine wreathed, is a burden to my
spirit.   I can get along in a very small room for myself and my
belongings but I *must* have some space outside my window.   When I
had to live in the city I had such longings to escape that I would take
a car in dead of winter and go to the end of the route and then walk
until there was not a house or a person in sight and so get my
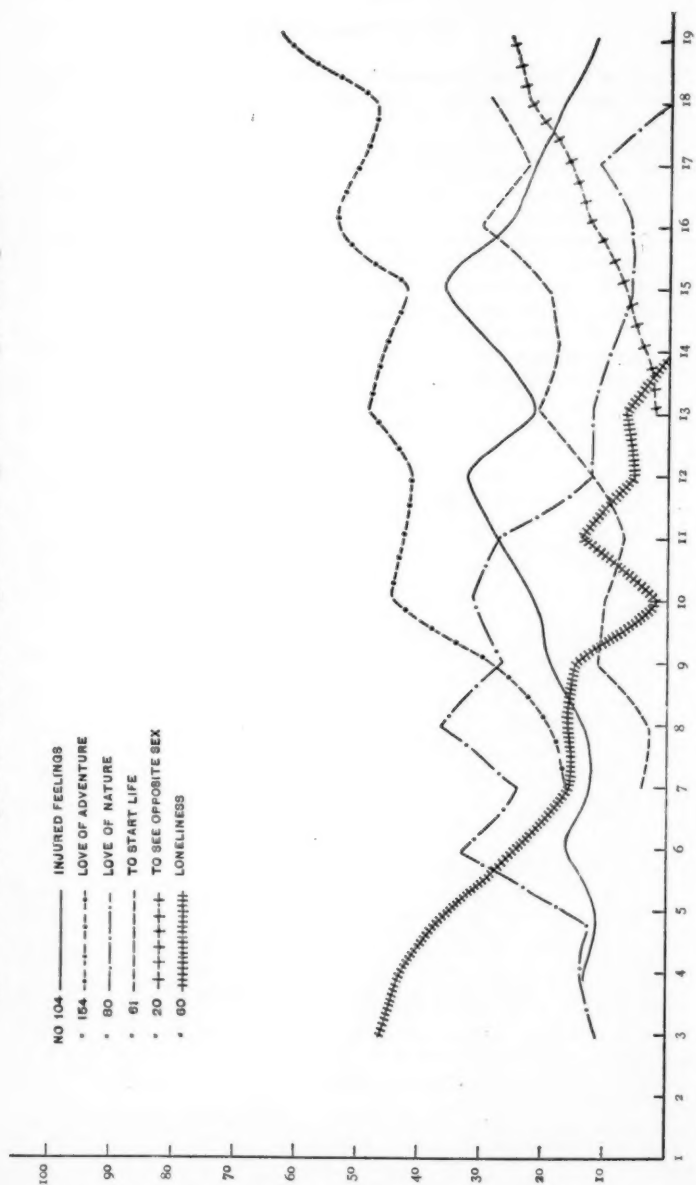equilibrium."

A student of tramps and vagrants writes me :

"It is my impression that the narrow, cramped conditions under
which boys often live, without sufficient variety and wholesome
interests in their lives, is responsible for much of the constant recruit-
ing in the ranks of the tramp army.   It is unnatural for young people
to live a life of dead monotony, and the boy who breaks away in sheer
desperation, without an education to equip him for any better life,
soon drifts to trampdom and becomes irreclaimable to serious life."

While the charms of travel woo many to a roving life, trav-
elling, especially on water, cures many of a roving passion.
The following are from 280 cases of Rubric IV on the charms
of travel :

CHARMS OF TRAVEL. 3. M., 26. " I enjoy a walk into far away
country places for the sake of the sensation of delicious freedom, of

CHART IV. *Showing the relation between ages and the different causes for leaving home.*

NO 104 ——————— INJURED FEELINGS
" 154 —— ·· —— LOVE OF ADVENTURE
" 80 —— · —— LOVE OF NATURE
" 61 —— —— —— TO START LIFE
" 20 +++++++ TO SEE OPPOSITE SEX
" 60 ++++++++++++ LONELINESS

the perfect mental abandonment. One feels as if he had shaken off the dead weight of mental contact, and the far off stretches of country promise more of the same kind of liberty."

4. M., 24. "I like being aboard a ship for the feeling of endless space and a sort of liberation from conventions that it brings. A long walk into a new part of the country has a charm for me. And I have enjoyed herding cattle on the prairie because it set me free from self-consciousness."

5. F., 33. "Have often felt as though the house, although comfortable and handsome, was choking me, and the moment I got my foot on the doorstep for a walk, even though a deep snow prevailed, I felt better. I feel intense pleasure when walking in the twilight—alone, have an elasticity of step and elation which makes me wish twilight would last for hours so that I could walk miles. Am in no sense a gad-about, and I hate call-making, but cannot hear the whistle of a locomotive without a tingling of the blood and a longing to be off—indefinitely, anywhere. Have led a sedentary life."

6. F., 21. "Either a trip on the ocean or a long ride on the train has great interests for me. The former soothes, puts me at peace with the whole world; the latter excites me, I feel boisterous, can hardly keep still, no matter how peaceful the scenery, it seemed that I could always see something wild about it, something that answered to my feelings."

7. M., 26. "The chief interest of travel to me is the seeing of new things. My hobby in the way of change is to get out into the country for about two days at a time, drop everything, cut loose from every thought that binds me to my work and walk in the woods. With me there is a peculiar emotional tone that goes with thoughts of travel."

8. M., 30. "The novelty of seeing new things and having new experiences are the attractions of travel. I sometimes get tired of habitual surroundings—I think from the monotony and sameness of repeated experiences."

9. F., 16. "A day's walk through the woods has the greatest charm for me. The freedom, the wildness, the quietness, the birds, flowers, all answering to an inner feeling of joyousness; a feeling of being *at home* with nature."

10. F., 20. "The new sights. I like, too, the onward motion, the feeling that I am going."

11. F., 19. "I think I never had a desire to run away, but sometimes in spring I have had desire to go for a walk by myself; I have gone to walk through the fields and woods. It seems as though I wished to enjoy it alone and not speak to any one."

12. M., 20. "In my experience the bicycle has held the most interest in the charms of travel. It is akin to flying, the swift motion and delightful breezes fanning your head are pleasant sensations."

The thirst for travel is a product of a nexus of factors. In our 280 returns, however, two groups of motives have dominated. First they show that travelling is a favorite means to destroy monotony, it breaks up the tedium of the hour; it shelves old experiences and sensations, that have induced a sort of mental cramp or fatigue. Travelling relieves this cramp by furnishing a superior sort of new psychical and bodily activities; second, they indicate strongly that the desire to experience sensations of motion is unique among human passions. Josiah Flynt says: "The possibility of

riding everywhere afforded by our net work of railways is
alluring to the boy and often wins many to trampdom.''
Shaler thinks the love of adventure (chart IV) can best be
satisfied by going to sea.

The sensation of motion, as yet but little studied from a
pleasure-pain standpoint, is undoubtedly a pleasure giving
sensation.   For Aristippus the end of life is pleasure which he
defines as gentle motion.   Motherhood long ago discovered its
virtue as furnished by the cradle.   Galloping to town on the
parental knee is a pleasing pastime in every nursery.   The
several varieties of swings, the hammock, see-saw, flying-
jenny, merry-go-round, shooting-the-chute, sailing, coasting,
rowing and skating, together with the fondness[1] of children for
rotating rapidly in one spot until dizzy, and for jumping from
high places, are all devices and sports to stimulate the sense of
motion.   In most of these modes of motion the body is passive
or semi-passive, save in such motions as skating and rotating
on the feet.   The passiveness of the body precludes any im-
portant contribution of stimuli from kinaesthetic sources.
The stimuli are probably furnished, as Dr. Hall and others
have suggested, by a redistribution of fluid-pressures (due to
the unusual motions and positions of the body) to the inner
walls of the several vascular systems of the body.

Love of adventure (see table III chart IV) is apparently
prompted by a variety of motives, $e.\,g.$, by rebellion against
restraint, love of freedom, of travel, thirst for knowledge,
chivalry ; and also by the dare-devil, iconoclastic spirit that
revels in the unexpected and courts fortune through the factors
of lottery and chance.

Rubrics I, II, concerning runaways, and IX and XI, pertain-
ing to homesickness, etc., are treated in a comparative way
(table IV) as interesting from a sociological standpoint and
as a further introduction to the material of section C.

Probably the most general and fundamental group of facts
are those pertaining to the home and parents.   The percentage
of orphans in both lovers of home and runaways are compara-
tively small.

Tenanting is much more common among parents of run-
aways — 35% as against 18% for lovers of home.   The
conditions of the home are classified into poor, moderate,
comfortable and bountiful.   The largest number of homes in
both groups belong to the comfortable class.   An examination
of all the classes shows that the runaways bear by far the
greatest number of inferior homes in an economic sense.

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[1] Hall, G. Stanley :   Study of Fears :   *Am. Jour. Psy.*, Vol. VIII,
No. 2, p. 157.

Nineteen per cent. of the runaways come from poor homes as opposed to no per cent. of home lovers. It is unnecessary to comment on the rest of the items compared—the table is self-explanatory.

TABLE IV.

Showing the comparative sociological conditions, traits, etc., of five hundred (500) runaways and two hundred and twenty-five (225) lovers of home (ages 1–20 years).

RUNAWAYS.		Per cent.	LOVERS OF HOME.	Per cent.
Parents. { Both living	. .	86	. . .	80
Partially orphans	.	11	. . .	16
Wholly orphans	.	3	. . .	3
Do not own their homes	. .	35	. . .	18
Conditions { Poor	. .	19	. . .	0
Moderate	. .	30	. . .	6
of home. { Comfortable	. .	40	. . .	58
Bountiful	. .	11	. . .	23
Not affectionate	. . .	45	. . .	9
Physically defective	. . .	12	. . .	0
Numerical { Oldest	. .	23	. . .	20
relation in { Youngest	. .	25	. . .	32
the family. { Only	. .	23	. . .	2
Neither	. .	28	. . .	45
Sensitive	. . . .	62	. . .	90
Demonstrative	. . . .	60	. . .	32
Laugh easily	. . . .	70	. . .	79
Cry easily	. . . .	62	. . .	73
Generous	. . . .	74	. . .	87
Careless in dress	. . .	52	. . .	10
Like crowds	. . .	79	. . .	36
Shun crowds	. . .	21	. . .	64
Careful of property	. .	61	. . .	90
Regards others rights	. .	64	. . .	93
Made no collection	. .	45	. . .	12
Persistent in tasks	. . .	74	. . .	85

SUMMARY.

The discussion of migration of animals indicates that the most general initiative factor that disturbs the psycho-physiological adjustments is the procreative function, but that the mode and time of its operation is greatly modified by cosmic forces.

We do not trace with equal certainty the operation of the same factors in the same order and effectiveness in originating and controlling the instinct in man for the obvious reasons that he has freed himself to a great extent from these archaic forces and in a measure controls them; besides he has set up a *social cosmos*, as it were, of his own that must be obeyed. Despite these hindrances, however, we do get traces here and there of the persistency and effectiveness of *the inner, the cosmic* and the *social* forces involved in the differentiation

of the instinct. The movements of primitive man were controlled, in all probability, by the distribution of certain foods, by the physical geography of the country, and by the change of seasons. The factors of climatology together with the topography of the country have greatly controlled, if not actually touched off, the instinct as seen in historic migrations.

The passions for local roving, "gadding about," frequent moving and gypsying is a reassertion of the old psychoses that was formed when to know friend and foe were essential to self-preservation, and when the highest conditions of lot and chance were assiduously courted. Spring fever, ennui, psycho-physiological disturbances of spring, and of the lunar as well as certain solar periods, then, too, the vernal increase in the number of marriages and in the number of illegitimate births ; the strengthening of the love of adventure, for independence and freedom at the onset of puberty ; the greatest number of runaway adolescents occurring in the spring — all alike point to the general conclusion that the procreative functions and their irradiations and cosmic periodicities are joint factors in the differentiation of the migratory instinct. They are the factors that have ever periodically disturbed whatever adjustment that man may have effected with his environment on a vegetative basis.

Finally, the migratory instinct is general, if not universal. It is merely a matter of degree — sometimes very slight, too — from the mental throes, perturbations and secret threats of leaving home by the adolescent to their actual occurrence. The gradual passage from the adolescent who fights and smothers these several subjective upheavals and remains at home, or from the one who subdues the desire for change and continually adjusts himself to present tasks to the one who is overcome and breaks away is paralleled by the fine shades from sanity to insanity, or from the feint inner thoughts of to the actual committing of crime.[1]

We are not then dealing with anomalous elements and characters. The germs and even at times the full fruition are in us all, partly as a heritage and partly acquired. (See cases 1 and 2.)

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[1] Ferri, E.: Criminal Sociology, p. 43 — "Every man, however pure and honest he may be, is conscious now and then of a transitory notion of some dishonest or criminal action. But with the honest man, exactly because he is physically and morally normal, this notion of crime which simultaneously summons up the idea of its grievous consequences, glances off the surface of the moral conscience . . . with the man who is less normal and has less forethought, the notion dwells and finally prevails."

SECTION C.

LOVE OF HOME.

The love of home is indeed an archaic theme in literature. An activity of the soul that arose very probably soon after the sex broad-ax dichotomized organic life. To build a home, furnish and protect it absorb the quintescence of the energies of the greater part of living species[1]. The instinct is expressed oftentimes in an unmistakable manner by the unnatural and waning activities of wild animals in captivity longing to return to their familiar haunts.

Werworn[2] found that many lowly forms of pelagic life, although under the very best conditions, decrease considerably in volume in a few days, many die within less than a week. He kept beroës alive three weeks. One beroë that measured 2 cm. long, after 14 days captivity was only 6 mm. long.

[3] Young shows that in vessels of the same shape the larger the area of the vessels, the greater the growth of tadpoles confined therein. [4] De Varigny has found the same to be true of the pond snail. He interprets this dwarfing as a physiological or mechanical *impedimenta* to movements, *i. e.*, he would make free exercise one of the functions of growth. Darwin observes that insular animals are smaller than their continental congeners. For instance, in the Canary Islands the oxen of one of the smallest islands are much smaller than those of the others, although all belong to the same breed ; the same is true of their horses. Spencer says " It is well known by all anglers that trout and other fishes are small in small streams and large in larger rivers."

According to Bates, only one of the largest species of the South American turtles will live long in captivity, the smaller ones die in a few days. Snapping turtles generally refuse food and remain shy and fierce, but taken young can be brought to feed. Sea snakes cannot be kept alive many days even in salt water. The vipers all vomit their food after being taken captives and will seldom take any further nourishment except water. [5] Jordan found that female newts kept in confinement all winter were not so apt to lay eggs in the spring as those freshly captured. The

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[1] The agricultural achievements of the ant common in several lands, the variety of architectural designs for the home and the certainty and cleverness of their execution as seen in the life history of ants, bees, fish, birds and both lower and higher mammals, furnish abundant examples of the large bulk of animal activities exerted for the realization of a and its belongings.

[2] Werworn : Plfüg. Archiv., Vol. L, 1891, pp. 439–440.

[3] Young : Arch. des Sci. Phys. et Nat., Vol. XIV, 1885.

[4] De Varigny : Experimental Evolution.

[5] Jordan : Habits and Developments of Newts, Jour. Morphology, Vol. VIII, pp. 269–366.

duckbill[1] and pouched mole in spite of all care and attention live but a very short time in captivity.   Hartmann, Chaillou and others give several instances of young monkeys dying soon after capture.   Captured adult pumas[2] invariably pine away and die.   Delboeuf[3] allowed two different species of lizards to run together in his laboratory for over two years.   One disappeared suddenly for three weeks, during which time the second one refused all food, and had no relish for insects and earthworms until the absent one returned.   A species of snake (pelias berus) usually refuses all food ; but if the floor of its cage is made to look like its native moor it will sometimes feed voluntarily.   Cornish[4] says nearly all animals dislike solitude and confinement.   Tame hawks and falcons, if kept alone in a room mope and lose condition, and in some species a suicidal instinct is developed.   Merlins kept in solitary confinement destroy their claws and toes.

These citations, though by no means exhaustive, illustrate that not only forcible curtailing or limiting conditions for exercise, but a sudden change of environment, feeding grounds or even loss of companionship will cause dwarfing, sickness and even death to wild animals.

Instances[5] of the love for home among domestic animals and their intense mental sufferings when away per force were given in Section A.

Some of the factors making for the *love of home* in man are set forth in the cases below.[6]

1.   F., 19. " I think that the order is mother first, father and brother equally.   I like to think of my surroundings, at home in this order, the sittng-room, the two maples in the yard, the brook and the surrounding hills."

2.   F., 20. "The elements in my own love of home are first my father, then sister, brothers, the house, and familiar spots on the farm."

3.   F., 17. ". . . Father and mother and next my sister and brother— then the home feeling which I have but which I cannot possibly explain."

The family as a whole or the member in the manner given in these three cases, of course, take precedence over all other elements in all the returns, therefore, they are omitted in the rest of the cases.

4.   F., 25.   Scenery and past association.
5.   F., 20.   House, water, hills, trees, familiar ways of life.
6.   F., —.   House, natural scenery, familiar ways of life.

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[1] Bennett, G.:   Gatherings of a Naturalist in Australasia, 1860.
[2] Hudson :   The Naturalist in La Plata, p. 44.
[3] Delboeuf, J.:   Pop. Sci. Month., Vol. L, pp. 395–99, 1897.
[4] Cornish, C. J.:   Animals at Work and Play, '96, pp. 31–38.
[5] Selected at random from 200 answers to Rubric XIII of Syllabus.
[6] Selected at random from 160 answers to Rubric X of Syllabus.

7. F., —. Friends, location and familiar scenes.
8. F., 18. House, hills, and mode of living.
9. F., 25. Natural scenery and associations connected with it.
10. M., 19. Of my father, mother, brother, it would be hard to tell which I love most. They are all a part in my life. But of the house and surroundings, hills and valleys, there is that lasting feeling which ties me to it.
11. F., 21. Hill, trees, and natural scenery around my own home seem dearer to me than those of any other place.
12. M., 25. Familiar ways of life, all the familiar parts of the house; its nooks and crannies, where old associations and memories cluster thick as swarming bees; the plot of ground about the house, and lastly the outlook from its doors and windows, such as hills, trees, lawns, etc.
13. F., 22. The room where we sit together evenings, my own room, my bird and other household pets, the scenery, especially the mountains.
14. M., 22. House itself, trees that stand before it, a hill back of it.
15. F., 26. Familiar books and furniture, and the sincerity and naturalness of home relations.
16. M., 27. Habit I think enters strongly into my love of home—accustomed faces, furniture, surroundings, etc.
17. M., 30. Familiar haunts, chance to relax and feel easy.
18. F., 21. Distant hills, domestic animals and pets, home habits and family ways.
19. F., 22. The house itself because I was born there—then the woods and fields, which abound in nooks so pleasant to me, familiar ways of the people about the town.
20. F., 18. Naturalness of home life, the cozy surroundings, trees, flowers, the peaceful river and sceneries, the sociability of friends.
21. F., 18. Ways of the home, everything seems familiar, the good times we all have together, freedom of the home, always open to my friends and all friends of the family.

Ninety per cent. of the cases are females. By far the great majority (62%) rank mother first, father second (30%). Some (3.7%) say that the members of the family do not separate out into individual preferences. They regard the family, as a whole, the strongest factor. Two per cent. rank parents first, followed by other members of the family. A very few (1%) think a brother or sister is first choice. Females have more preferences among members of the household, or, at least, hesitate less to undertake an analysis.
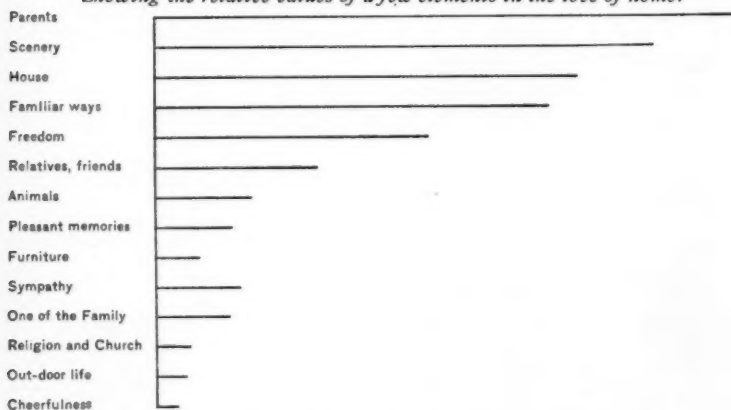
After members of the family the most common element is the *natural scenery* about the home (85%). This[1] consists of garden, lawn, familiar spots on the farm, trees, grove, river, brook, lakes, water falls, hills, distant mountains. Then, too, sunrise and sunset—on the prairie, or on the mountain, or from my window. The *house itself* (70%). Because I was born there—always been my home, its cozy rooms, especially my room, all my things are there. *Familiar ways* (65%),

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[1] Per cents are estimated on the number of times the factors are mentioned.

the sincerity and naturalness of home life, the home "feeling,"
quiet way and way we do it, time for meals, table manners,
evening chats. *Freedom of the home* (43%), place to relax
and feel easy, absence of restraint by strangers, freedom to talk
without fear of offending, to go where and when I please, free
use of all the house. *Relatives and friends* (25%), genial
ways, interested in me, good times together. The relative
strength of these several elements is illustrated diagramatically
in Diagram II. One is surprised at finding sympathy so low
among the elements enumerated. Phrases like the following
occur : Sympathy for my work ; for my troubles ; for my in-
clination ; for my plans.

DIAGRAM II.

Showing the relative values of a few elements in the love of home.

Parents	
Scenery	
House	
Familiar ways	
Freedom	
Relatives, friends	
Animals	
Pleasant memories	
Furniture	
Sympathy	
One of the Family	
Religion and Church	
Out-door life	
Cheerfulness	

The love of home, it appears, is a complex of at least three
general groups of factors : first, the personnel of the family ;
second, the variety of home life, both as to activities and
material objects, especially objects in nature ; third, the rela-
tion of the first two groups to self. If this relation is one in
which the self-regarding interests have been administered to,
the intensity of home love is usually a strong one.

It is noteworthy that those whose home affections are ex-
clusively for members of the family, were the children of
parents that moved frequently, or lived in tenement flats, and
thus were robbed of the associations of trees, hills, mountains,
lakes, and so on. The following cases are typical :

22. F., 25. "My love of home is almost entirely personal, as we
live in New York city flats."
23. F., 21. "I love my home because it is the place where my

mother and father live. The hills do not especially strike my sense of the beautiful or the picturesque, as they only vary from about four inches to one foot in height. We have one tree in our yard, and it would not take very long to count the leaves on it. The natural scenery consists of rows of brick houses."

24. F., —. "My love of home is very strong, but I don't know that I can specify the elements in it. I think it cannot be the house or natural scenery, for until I was about grown I had never lived more than a year or two at the same place (being an itinerant preacher's daughter). I grew up with the feeling that wherever papa and mamma were was home."

25. F., 33. "I have known three homes. All handsome. In two of them my position was that of sister, in the third, wife. I find that the sense of home exists only with the sense of *personal possession* and *responsibility*, and *congenial ways of life*."

Some factors lying apparently at the basis of the affections for home are emphasized by answers to Rubric IX. Eighty per cent. of the cases (104) are females.

26. F., 20. "Always hated to stay away from home, feeling that something might happen to my people, or that my mother might die before my return."

27. F., 18. Until within a few years past never objected to be away from home. Lost her father at 12, and since then will only very reluctantly leave her mother over night.

28. F., 15. Would never go out to parties or out with other girls. At her mother's wish she packed her trunk and made ready to spend a summer vacation in the country. She started several times, broke out crying each time, and finally gave it up.

29. F., 22. Gets homesick away over night even with her sister.

30. M., 38. Very systematic in habits, does everything by clock-work. Sociable and full of fun, but never goes away from home even for a night. Has been in the same office for 20 years. As a boy did not care to gad about the streets.

31. "Common thing for people of middle life to say it is an effort for them to get away from home, and that they can sleep better in their own beds. Know a lady of 25 who never likes to go on a vaca-tion. A week away seems very long, ... is not happy or at ease until in her home again."

32. M., 30. Very conscientious, an indefatigable worker, could never rest away from home *unless* his family were with him. Wants but a few friends.

33. M., 64. Does not like to be with crowds, never stayed away from home many nights in his life, dislikes to get out sight of the house.

34. F., 17. A regular home girl, good housekeeper and manager. Dislikes to meet strangers. When 12 or 13 would go occasionally to spend the night with a cousin, but scarcely found sleep. She seemed to be attacked with all the horrors of homesickness, would cry nearly all night. Afraid that mother might die that night.

35. F., 55. Married and lived on a farm, no family. She and her husband very often do not speak for weeks. She is fond of company, but never leaves home except to go to the market. She is very am-bitious to make money. I think that is why she stays at home so closely. She is afraid to leave home lest something might go to ruin.

36. F., 88. Has, and always has had the intensest love for her lit-tle wee shabby home. She cannot bear to be away from it a moment just for sheer love of it. Just as a loving mother cannot bear to leave her

little baby. She cares for it in a way that is almost caressing in its
fondness and prettiness. She permits no one to do a thing for her.
She cleans it, scrubs it, and keeps it dainty with the utmost joy. I
know from things she has said to me that it would pain her to have any
of her dearly beloved house utensils carelessly used or handled. She
once gave me a pretty piece of old-fashioned ware because she said that
her grandchildren would be likely to break it if it was left to them,
and she did not like to think of it ever being broken.

Last summer (her 88th year) she made her own garden, planted
and hoed it. She had it plowed, but that was all. She could not bear
to have any one touch it but herself. Her two sons, who live near by,
would gladly do everything for her. Whenever I go there she takes
me all over the little baby house, down cellar, into the woodshed, the
pantry, shows me her cistern, her dishes and everything, just as we
used to show off our playhouses when children. She is a woman of
exquisite, native refinement; her thoughts are all very poetic and lovely
thoughts.

Section B (Table IV) calls attention to the home life of
home lovers as usually congenial and quite comfortable in a
material way. Their lives are industrious, quiet, uneventful,
conservative. [1]Guppy says: " It was the boast of a wealthy
old Devonshire yeoman, 150 years ago, that he had never
crossed the borders of his native country, and I cannot believe
that in this respect he differed greatly from his fellows. . .
This gave solidity of character to which the long persistence
of families in the same locality and in the same stations is
mainly due." They love order, fond of systematic work, and
believe that there is a virtue in doing things at fixed times.
Some spend life happily in one place tinkering and puttering
away at odd jobs. Cases 50, 54, 55 and 56, represent a large
class that make few friends, retiring in disposition; dread
meeting strangers, entering a new place, or even sleeping in a
strange bed; are in constant dread when among strangers
either of *boring* some one or getting *bored*. They have more
fears than rovers and gad-abouts. Although they shun crowds,
hospitality and open friendship are found at their homes.
Many are fond of company, and delight in the duties of hostess.

Habit, born of necessity, doubtless explains much of the
phenomena. Some are suddenly and almost pitifully attached
to their homes through some shock occasioned by a death in
the family (case 48), or by sickness contracted away from, or
by some other unexpected misfortune. They come to feel that
to leave home will in some mysterious way precipitate a dire
calamity. This feeling and nervousness often becomes so in-
tense at leaving that the journey is abandoned. Thus sorrow
and disappointment may greatly intensify the home feeling.
The dread of meeting persons, shunning the effort to bear
up the "dead weight" of the presence of strangers, the fear

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[1]Guppy, H. B.: The Homes of Family Names.

of not being welcome, of injuring some one's feelings indicate, at least, a strong coincidence between the fear of persons and the love of home. Dr. Hall[1] finds that the fear of persons ranks third, exceeded only by the fear of thunder storms and reptiles.

They may grow homesick or timid or their resolution to stay away may break down at the approach of night. They are afraid " mother might die " (case 56) ; something " at home might go to ruin " (case 57) ; " something fatally done " (case 45), or that they will never see home again, that they themselves may die that night. One after returning home examines every shrub and flower in the yard to see if they are unharmed (case 34), another goes straight to her room to see if all her things are as she had left them, and so on. May not this unusual unrest and anxiety about home and its belongings be a remnant of the bitter and costly experience that man along with so many other species must have suffered through the neglect of properly guarding or hiding the home.

Many species of life must have had some such experience, otherwise the origin of the widespread instinct to post sentinels or place some obstacle in the way of approach to the home is still unsolvable.[2] The home of whatever species, being the center of family possessions has always been the one tempting object for attack and pillage. Even civilization like modern frontier life is not without its lessons of wrecked homes in the absence of its natural protectors. It would be a wonder if these bitter experiences during the evolution of the home from the ill-provised tent of the nomad to the modern brown front had left no trace upon the soul.

The feeling of comfort and ease based on habit,[3] familiarity and freedom is nowhere fostered as in the home. The feeling that our ways are better ways, the difficulty to adopt one's self to other ways of life than those learned in childhood are just so much data on the general laws of habit. It weds every one of us to the manners, nooks and crannies, hills, valleys, lakes and forests of our own home and neighborhood. The sense of familiarity so frequently mentioned is but a function of habit. We like the feel of things, welcome under all circumstances, the "warmth and intimacy," the naturalness of home relations. What is this naturalness but a maximum reduction of friction through habit? Along with familiarity runs a deeper

[1] Hall, G. Stanley: *Amer. Jour. Psy.*, Vol. VIII, No. 2, 1897.
[2] Ants, bees, species of fish like the stickle back, species of birds, monotremes, prairie dogs, many herbivorous and several species of monkeys post sentinels to give the danger signal or do battle for the home when attacked by the enemy.
[3] James, William: Psychology, Vol. I.

feeling, that of freedom.   At home I can do what I like, have a chance to relax and feel easy, and throw off conventional restraint.

The fact that natural scenery ranks next to members of the family as a factor in the love of home justifies further investigation — far more than this paper contemplates.

There is little doubt now but that "gods[1] of the early world are the rocks and the mountains, the trees, the rivers, the sea." The primitive mind did not even distinguish animate from inanimate objects, but both alike possessed life, passions and spirits.   Along with this belief in the general animation of everything went the belief in metamorphosis.   Their gods were creative.   "In Greece[2] the stories of the descent of man from gods stand side by side with ancient legends of men sprung from trees or rocks, or of races whose mother was a tree and their father a god.   Similar myths, connecting both men and gods with animals, plants and rocks, are found all over the world and were not lacking among the Semites."   In addition to being objects of worship, trees, rivers and mountains have always been favorite places for worship.   The word kirk, now softened into church from quercus oak, indicates early religious use of trees.   Preferences for certain waters in rituals is evidenced by Naaman's indignation when he was told to bathe in the Jordan instead of the rivers of Damascus.   Again we read : " The hour cometh when ye shall neither worship in this mountain . . . ."

The application of flowers and plants to ceremonial purposes is of the highest antiquity.   Of forests Coulter[3] says :   " There is solemnity about them, a quiet grandeur, which is very impressive, and the rustling of their branches and leaves has that mysterious sound which caused the ancients to people them with spirits.   We still recognize the feeling of awe that comes in the presence of forests."   Rivers and springs, trees and plants have long administered to the ills of man.   The mountains have furnished him shelter from storms and enemies.   The feeling of the child and adolescent for stream and forest has already been indicated.   Truly, the race has lost none of its attachment for these archaic friends.

The love of home viewed from the standpoint of nostalgia adds emphasis to matter already presented and gives renewed interest to somewhat old psychological problems.   Some typical cases of nostalgia are presented, taken from 176 reports on that topic.   Six per cent. of the members report as having never been homesick.   Eighty-seven per cent. are females.   This

[1] Fergusson :   Tree and Serpent Worship, p. 54.
[2] Smith, W. Robertson :   The Religion of the Semites, p. 86.
[3] Coulter, J. M.:   Nature and Art, Vol. I, p. 1, 1898.

large percentage I think is due to the fact that eighty-six per cent. of those that answered the syllabus were females. No sharp line can be drawn between loneliness and homesickness. The latter is oftentimes preceded by a brief period of the former.

1. M., 4. Whose parents had moved to a new neighborhood, said even before the house furniture had been put in order, "Let's take the cows and go back home."

2. M., 5. Became very lonely and homesick to return to the old home from which parents had just moved. When questioned why he wished to return, said, "I want to get my playthings." They consisted of a stick horse, a few pebbles and broken dishes.

3. F., 21. "When I first entered school I was homesick for several weeks. If lessons were hard and I found much difficulty in mastering them, I would get a longing for home that would not leave me until after a night's sleep."

4. F., 19. "Have never experienced intense feelings of homesickness, although I have longed to be at home at times when dissatisfied with my surroundings or my work. The feeling wore off with increased interest in my work."

5. F., 20. Experienced homesickness only for a short time and then it was mostly due to lack of employment.

6. M.. 5. Went to stay all night with a neighbor only a few rods away from home. Became so homesick that he had to be carried home even in the night.

7. F. "At about eight visited an aunt. At night I would cry myself to sleep thinking of the pleasant ways at home. I felt forsaken and forgotten, worried about accidents that might happen at home. I was afraid some one would die before getting home."

8. M., 21. "At 10 went to spend the night away from home for the first time. Made it all right during the day. At night was seized with a tremendous longing to be at home. I was helping to shell peas, put one in my mouth but could not swallow, I felt so badly. Without saying a word put on my hat and walked home two miles in the dark."

9. M., 19. "Could not eat, whenever I would try I would choke up. Felt sick all over. Did not want to say anything—was thinking of home all the time—could not think of anything else. There was sort of a smarting sensation in my stomach, and I *felt faint.*"

10. F., 18. (First term in boarding school.) "I *felt dazed* and for a long time I could not realize why I was where I was."

11. M., 24. "I cried every day for three weeks about sundown. I could not tell why I cried, for I had been very anxious to go away to boarding school and would not have gone home had I had the opportunity."

12. F., 10. "I used always to get homesick if separated from my mother; but if she left me at home, it was not so bad as when I left home—suppose the familiarity of home surroundings lessened the sickness."

13. F., 22. "At 12 while in school became homesick and finally ill. The physician said their could be no marked improvement while I remained from home, as that was my one thought. I had not been home but a few hours when I ate a hearty meal and slept well, and in one week was well again, while the day I came home I had to be carried up stairs."

14. "All new girls at this school were placed in the back part of the hall, which was dark and gloomy. Looking out of my window I

could see any number of tin roofs, chimneys, back-yards, and servants passing in and out. These sights together with the coldness of the older students made me dreadfully homesick."

15. F., 22. At seven stayed away from home a week, could not eat anything and was always looking to see some house or scenery that *looked like home.*

16. F., 10. Was sent away to a school for girls—she was eager to go. Enjoyed the change at first but soon gave way to extreme homesickness. At the end of three months of school life she had become really ill—was very thin, ate almost nothing, had a heavy cough and was believed to have consumption. She was sent home and recovered in a few days.

17. F., 18. "Got along well during the day, but at nightfall would choke up and when the crickets, the "Katydids" (cicadae) and the low wind began to make a noise I broke down and cried myself to sleep."

18. "I was homesick once, at home, too,—(father and mother had gone away for some time). I was all alone in the old house. The feeling was similar to *nausea* only in a less degree with such a longing for some one to come."

19. F., 18. "I lost my appetite, could not be comforted, did not wish to talk, would get *dizzy* when I walked across the floor."

20. F., 23. "Do not lose my ambition to work but feel doleful, lose my appetite, so that I almost come down sick. Have a bad feeling all the time in the region of my stomach which ceases with the homesicknes. I think homesickness is the most appalling thing under the sun. It swoops down on one before one knows it and you cannot get rid of it." ǀ

21. F., 17. "An indescribable longing. I seemed sick all inside myself and all choked up."

22. F., 18. "I would always get sick at my stomach and often vomit. My family would laugh at me when I reached home and say it was homesickness. There is a feeling of pain, as well as I can locate, a little lower than my heart."

23. F., 30. "I always have a smothering sensation—everything seems closing in on me."

24. M., 22. "I feel melancholy, down hearted. There seems to be a lump in my throat—I feel that a good cry would help."

25. M., 23. "I lost both appetite and weight, had to give up work and go home."

26. F., 25. "My dreams of home make me homesick."

27. F., 18. "I felt unloved and unloving to all around me and could only conceive of happiness at home."

AGE. Forty-three per cent. of these cases (166) occurred for the first time at ages 16, 17 and 18 years. Eighty per cent. occurred for the first time from ages 12 to and including 18 years. The large number occurring at 16, 17 and 18 is due to the fact that conditions for homesickness were presented for the first time at these ages, *e. g.*, entering school or college, taking a new position, entering the navy or army.

Hack Tuke[1] thinks there are no general rules for its occurrence in the different sexes, ages and temperament. Papillon[2] says : "Nostalgia attacks by preferences, young people and

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[1] Tuke, Hack: Dic. of Psy. Medicine, Vol. II, p. 858.
[2] Papillon, Fernaud : Pop. Sci. Month., Vol. V, pp. 215-20, 1874.

those just entering youth, affecting all temperaments without distinction.''

''Adolescence is really the age for predilection to nostalgia,'' says Widal,[1] '' It is the age of delusion and of love. The young man is still under the influence of his childish memories which dispose him to recall the place where he has been happy and to magnify the charms of native land as soon as he encounters the first deception of life.'' An army[2] surgeon writing on the evils of youthful enlistment, and nostalgia says: ''Among young prisoners of war it is the most complicated disease to be encountered.'' Both the French and German army surgeons confirm this view; and all agree that fresh *youthful* troops from *rural* districts are often a positive hindrance to the efficiency of an army because of their predilection to homesickness. Widal believes that there are vague signs of it in babyhood. ''Although this affection may be incompatible with the infant, it is none the less true that, instinctively the nursing child is affected by all that surrounds it, and the tears which it sheds when one changes its food or removes its rattle are already vague feelings of nostalgia.'' My impression, based on medical literature and other material, is that in quality or intensity (cases 9, 25) nostalgia is just as severe and if allowed will lead to as fatal results before and after as those cases occurring in adolescence but that the latter is more predisposed to an attack than either childhood or manhood.

SEX. Tuke thinks no rules can be laid down regarding its relations to sex. Widal thinks woman is less subject to nostalgia than man because she can enter into new conditions and receive new influences without herself suffering any great change. This notion squares with the general theory that she is more conservative than man. ''Whatever may be the migration of woman her manner of life is less changed and like the ancient wanderers she carries her household gods with her.'' These are the reflections of a French army surgeon who had studied nostalgia in camp, prisons and hospitals, all three presenting the pink of conditions for the ravages of the disease. Had he been a physician to a cotton or woolen factory, a female boarding school, or a modern normal school, it is probable that his notions would have been considerably modified.

While the present study (eighty-seven per cent. females) indicates that women are more liable to the sickness, I hesitate

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[1] V. Widal: Dic. Eng. des Sci. Medicales, pp. 357-380.
[2] Peters, DeWitt C. (U. S. A. Surgeon): Am. Med. Times, Vol. VI, 1863.

in the absence of a wider range of data to draw any conclusions on this point.

Temperament and Nationality. It is generally agreed that the most diverse temperaments pay equal tribute to nostalgia, so that an attempt to make any classification on that basis is of no value. I find, however, that the majority of the cases are sensitive, not a few nervous, timid, sociable, affectionate; but they fear a crowd, dread meeting strangers, delight in the simplicity and shelter of domestic life. Another class occurring often enough to mention is the phlegmatic, the taciturn. They are described as "difficult to entertain," "prefer to be by themselves," "interests are odd or provincial." They move in a self-created world. With but few exceptions the cases are Americans of Anglo-Saxon stock. A few pitiful cases of foreigners unable to speak our language are reported.

A French writer says : "That every one imagines that his native soil is distinguished from others by signal favors, by particular and rare attributes, and that nature has need of this illusion in order to keep each man in his own home." Widal thinks that the predilection to nostalgia is inversely to the degree of civilization of a people. Sagos, quoted by [1]Papillon, says "that love of country is strongest with those who are nearest to a state of nature." Savages living under the rudest forms of civilization, in the most uninviting climates, grieve when they quit them. A Lapp brought to Poland where every kindness was shown him, was seized with incurable sadness, and at last escaped and returned to his inhospitable country. Greenlanders taken across to Denmark risk certain death by trusting themselves to slight canoes to cross the ocean separating them from their own land. Pocahontas, fondled and caressed by London society, grew homesick for Virginia's woods and finally wasted and pined away. The Psalmist [2] records Israel's yearning for their Judean homes while captives in Babylon. "By the rivers of Babylon, there we sat down, yea we wept, when we remembered Zion. We hanged our harps upon the willows in the midst thereof. . . . How shall we sing the Lord's song in a strange land?"

Nationality. Switzerland is the classic land of nostalgia. The love of freedom and independence of the inhabitants, their love of family life, the pure air of the mountains, the charming scenery of which the accentuated outlines become etched into their very souls are all elements that make for love of home. Next come the French. The disposition to the disease diminishes roughly in proportion as one advances toward the middle of the country[3] (France).

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[1] Papillon, Fernaud : *loc. cit.*, p. 218.
[2] Psalm CXXXVII, Verses, 1, 2, 4.
[3] Based upon thousands of cases in French military hospitals.

English and Germans leave their country with less reluc-
tance than the citizens of other countries.   More cases occur
among German troops in foreign lands than among the
English, whose adventurous and cosmopolitan spirit (his coun-
try is wherever his flag floats), his commercial predilection
immune him from nostalgia without removing in the least his
attachment for his country.

Dr. Peters[1] describing the ravages of homesickness among
fresh troops quartered in New Orleans (1862), says :   '' This
was notably true of soldiers from New England, where it
appeared that the love for home was very strong.''

Dr. Calhoun[2] writes :   '' It is a matter of common remark
in this army that troops from the country have a much larger
percentage of deaths than those recruited in the cities.''   He
thinks that the peculiar susceptibility to nostalgia of those
from rural districts is due to the fact that a country boy is
more at home, seldom takes his meals at other than the family
table, seldom sleeps away from home, has less temptation to
leave it, and thinks more of it and its influences than he who
in the city spends his days in the workshop or counting-room,
and his nights at the thousand and one places of amusement a
city affords ; then, too, the city boy gets his meals at the res-
taurant or the boarding-house.

Facilitating Conditions.   By these I mean the variety of con-
ditions in which nostalgia occurs and the factors that may
aggravate it.   Fifty per cent. of the cases reported occurred
on entering school—even the first day of school.   Others
occurred while making a visit in the country from the city, or
vice versa, or in beginning the first school, taking a new posi-
tion among strangers, moving to a new neighborbood, to a
foreign land, being left alone at home, taken sick away from
home ; again seeing or meeting some one from home, or even re-
ceiving a letter, is sufficient at times to touch off the pent-up
feelings.

Idleness, the mother of a motley host of delinquent off-
spring, is exceedingly prolific in this disease (case 5).   Among
soldiers[3] and sailors, idleness, coupled with suspense and lim-

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[1] Dr. Peters: *loc. cit.*, pp. 75-6.

[2] Calhoun, Th. J.: Nostalgia as a disease of field service.   Medical
and Surgical Reporter, Vol. XI, p. 131, Phil., 1864.

[3] In military life the beginning and the close of service is marked by
increased nostalgia.   '' When I took charge of the division they were
losing men by death daily.   That it was not due to local causes was
proved by the fact that adjoining regiments exposed to the same local
influences, lost none, and of the patients at our division hospital,
with the same diseases (typho-malarial fever and camp dysentery),
those from the 120th N. Y., Vols. died under the same treatment that
the others got well on.   The regiment is from one of the river counties

ited freedom, is more than the ordinary soul can endure with equanimity. It wrings the cold sweat from the stoutest.

According to my returns nightfall exceeds all other elements in aggravating and intensifying the sickness. (Cases 12, 16, 18, 23, 35.) The stillness of the night, the chirping of crickets, the whispering of the leaves, the sough of the wind, new and strange noises, real or imagined, all intensify the gloom and forsakenness of the unfortunate. Dr. Hall's[1] study of Fears emphasizes the wonderful horrors that night holds in store for so many, even though surrounded by every comfort and protection. Less frequent aggravations are the reception of letters and articles from home ; dreams about home ; the feeling of goneness on facing the real after awakening ; friends offering sympathy ; hearing a familiar song. So strong and disturbing was the influences of a certain air on Swiss soldiers in the service of the French that it was forbidden to be played in their hearing.

Psychical Effects. It usually begins by feeling lonely, desolate, forsaken. "Longing for a lost past," "low spirited," "loss of ambition," "hard to cheer up," "no interest in surroundings." Desire to please, natural coquetry and regard for the opposite sex disappear. Some report : "I wanted to cry ;" "wanted to scream ;" "cried most all the time ;" "cried myself to sleep ;" "could think of nothing but home ;" "thought all the time on objects at home ;" "felt as if I would go insane." Sometimes it comes very suddenly. "It swooped down on me ;" "felt as though everything was closing in on me ;" "there is a smothering sensation ;" "feeling of utter despair came over me all at once." They may become iconoclastic. "Wanted to destroy everything in my way ;" "had no mercy on man nor beast until I reached home." In its last stages hallucinations and delirium set in, followed by complete prostration, stupor, syncope and death.

Bodily Phenomena. The three most general, if not universal effects, are (1) loss of appetite, (2) gastro-enteric troubles, (3) irregularity in respiration interrupted by sighing. Vague, erratic pains—variable in intensity—accompany all the symptoms, and become more and more localized in the head and stomach. Vomiting often begins early (case 31), the same is true of animals—the eyes become more and more fixed, dull,

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of New York state. Nearly all who died were farmers. Those who were sent on furlough got well, while those who remained died. But a still further proof is present. The battle of Chancellorsville cured the regiment, and it has since enjoyed as good health as any in the division. This leads me to the remark, that BATTLE *is to be considered the great* CURATIVE AGENT *of nostalgia in the field.*" Theodore J. Calhoun, *loc. cit.*, pp. 131-32.

[1] Hall, G. Stanley : *loc. cit.*

and languid and sunken in their sockets. The face is anemic, the whole body begins to emaciate ; the pulse is irregular and weakened, heart palpitates, temporal arteries throb. The mouth is dry and sticky. Nervous dyspepsia is very common, more often accompanied by diarrhœa, sometimes by constipation, ending in an absolute refusal to take food. There is incontinence of urine, spermatorrhœa, menstruation may be checked or suppressed altogether. Sexual functions are dulled. Pulmonary phthisis is sometimes mistaken for consumption (case 16). In a word, anabolic processes gradually approach a minimal activity, while the katabolic hasten to the maximal.[1] Sagar says : " It appears that the soul of the nostalgic no longer resides in the body, that it has broken off all commerce with it. All, however, agree to a general bodily phthisis sometimes more or less pronounced in the lungs.

The foregoing[2] facts and considerations impress one that nostalgia is a very fundamental reaction of an organism to fairly describable groups of stimuli. These groups are *primarily*, it seems to me, the absence or loss of the FAMILIAR, the presence of the STRANGE and UNTRIED, - and *secondarily* restricted liberty, change of food, habits of life and the like. The first group, especially, will engage us here.

Cases like 9, 10, 18 and 19 have suggested, what appears to be a probable solution — at least a point of view permitting legitimate speculation. Faintness, a dazed feeling, nausea and dizziness are the well known disorders of seasickness and vertigo.

Seasickness[3] is caused by a derangement of the nerve centers that control the equilibrating mechanism of the body. The sense[4] of equilibrium is furnished by every possible bodily sensation — both kinæsthetic and sensory. To retain[5] this sense, it is necessary that the information, derived from whatever source, should harmonize. Disturb the harmony and vertigo immediately ensues. Contradictory impressions not only disturb but often stop the equilibrating functions. Nowhere are these confused sensations so baffling as at sea. The point of

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[1] Physicians, like Haspel and Larrey, believed that it was caused on the physical side by brain and spinal lesions, cerebral hemorrhages and swellings of the arachnoid membrane, or by gastro-enteric lesions. These views are now discredited.

[2] Calhoun says "Nostalgia is an affection of the mind. It must be treated with that in view." Hack Tuke thinks that it always represents a combination of psychical and bodily disturbances. Sauvage describes it by four words: *morasitas, pervigilio, anorexia, asthenia*, which signify sadness, sleeplessness, want of appetite and exhaustion.

[3] Hudson, W. W.: Cause, Nature and Prevention of Seasickness.

[4] Howell : Amer. Text Book of Phys., pp. 846–47.

[5] Elsner, H. L., Dr.: The Medical News, Vol. LX, pp. 477–80, 1892.

rest (center of gravity) in the human body on a tossing ship is being constantly shifted. Persons unacquainted with these phenomena attempt consciously and unconsciously to make compensatory movements in order to maintain the old habitual land-sense of equilibrium ; thus inaugurating a struggle between equilibrium of habit and the equilibrium under novel conditions (sailors are adjusted to this novel sense of equilibrium). These repeated attempts to maintain an *arbitrary* center of gravity as it were, produce seasickness[1].

Nostalgia, it is true, is not a direct disturbance of the physical sense of equilibration, it appears as a secondary effect. The patient has, however, lost his psychical orientation. Just as the seasick patient has his center of gravity and consequently his physical plane of reference constantly eluding his bodily adjustments, so the nostalgic has his '' psychical plane of reference '' — composed of familiar scenes, friends, sense of security and the like — rendered uncertain and bewildering, through his inability to interpret and to enter into familiar relationships with the new world about him. To get on in this new world new adjustments must be made, old brain pachs must be dropped and new ones formed. He must fuse with a new stratum. The greater the unfamiliarity the severer will be the nervous shock and stress in trying to make a new adjustment, or to establish new relationships. As we have seen, many do not try to make a ''fusion'' at all, do not seek a new ''plane of reference,'' do not attempt to build new brain paths, but rather yield passively to their prison-world with wonder, timidity and fear. One experiences the beginnings of this phase of nostalgia on entering a familiar room in which the furniture has been rearranged or a piece taken out, or when one attempts a mechanical performance in a new situation, *e. g.*, writing or eating in a new place at the table, or when one looks into the garden or on the lawn where a conspicuous tree has been cut down.

The shrivelling and contracting effects of nostalgia on the ego are unique. Especially does this seem true of the social ego. In a strange land no one appreciates, applauds and sympathizes with my efforts, my boon companions are gone, I am isolated, cut off, but a mere machine grinding out a bit of the world's work.

MIGRANT VS. LOVER OF HOME.

The migrant is cosmopolitan, has manifold interests, and finds profitable objects and kindred spirits in a variety of situations.

[1] For a detailed description of the anatomical and functional relations of the organs (believed to be) involved in vertigo. See Dr. E. Woakes, Brit. Med. Jour., Vol. I, pp, 801-41, 1883.

McBride : Medical Times, London, 1881.

H. S. Lee : Jour. Phys., Vols. XV and XVII, 1894-95.

Howard Ayres : Jour. Morph., Vol. VI, 1892.

He may be found in the commercial, speculative, daring, progressive, macroscopic interests of the world. The lover of home is provincial, plodding and timid. He is the world's hod-carrier. His interests are identified with the conservative and microscopic affairs of society.

THE APPLICABILITY OF WEBER'S LAW TO SMELL.

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CONTENTS.

INTRODUCTION.

So long ago as 1834, in a paper entitled " De Tactu," Ernst Heinrich Weber first stated the law which bears his name, the first law of psychophysics. Working by the method afterwards called by Fechner " the method of just noticeable differences," he had discovered the law in its application to pressure and strain.[1] Before 1860 it had been proved to hold also for noise and brightness. Since the establishment of the first psychological laboratory, which occurred in the academic year 1878-9, and, oddly enough, but a few months after Weber's death, the validity of the law for the four sensation qualities mentioned has been over and over again confirmed.

Before 1860 Volkmann, Renz, and Wolf, by the method of minimal changes, had proved its applicability to noise. Bourger, Fechner, and

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[1] Wundt : *Physiologische Psychologie*, 4th ed., I, p. 381.

Volkmann, by their "shadow-experiments," and Masson with his ro-
tating disks, had shown its validity for brightness. Fechner had also
established Weber's conclusions in regard to strain by the method of
right and wrong cases. In the last twenty years, Tischer, Merkel,
and Starke, by the method of minimal changes; Merkel and Angell
by the method of mean gradations; and Lorenz, Merkel, and Kämpfe,
by the method of right and wrong cases, have confirmed for noise-
intensities the results of Volkmann ; Helmholtz, Aubert, and Kräpelin
have established for brightness the results of Masson ; and Merkel,
using the method of minimal changes, has also proved the conclu-
sions of Weber and Fechner in regard to strain. In the last six
or seven years, the experiments of Merkel by the method of aver-
age error have proved the extension of the law to those strain-
sensations in terms of which we measure distance by the eye, and
the experiments of Schumann by the same method give some indica-
tion of its extension to strain-sensations involved in our estimate of
intervals between one-half second and three seconds.

In case of the sensation-modalities for which the law has not
been proved, and in the case of tone, there are great difficulties
in graduating the intensity of the stimulus. Articular sensa-
tions, indeed, are not themselves graduated intensively. In
the case of tone, the difficulty is mechanical,—that of grad-
uating minutely the objective intensity of simple periodic
vibrations. In the case of the two temperature qualities, which
are peculiar in depending on different intensities of a stimulus
from a physical point of view the same in kind, and in passiug
into each other through a conscious indifference-point, the ex-
treme adaptability of the so far unknown and inaccessible periph-
eral organ makes the intensity of the physiological stimulus
begin to fall towards the indifference-point upon the applica-
tion of any new physical stimulus, and thus prevents the phys-
ical stimulus from being a measure of the physiological. The
sensation, moreover, varies in intensity with the extent of sur-
face stimulated and with the weight of the stimulating body.

The qualities of taste and smell form manifolds of indefinitely
related terms, which must be investigated separately. In the
case of taste, the list is at least closed. The intensity of the
taste sensation, however, is a function (1) of the degree of sat-
uration of the solution tasted ; (2) of the magnitude of the area
excited ; and (3) of the movement, diffusion, and pressure of
the substance tasted within the buccal cavity. No very satis-
factory way of keeping all but one of these factors constant,
while that one is varied, has as yet been found, though the in-
vestigations of Camerer, who worked by the method of right
and wrong cases, make the law of Weber appear to apply to
salt and bitter.

As for the applicability of Weber's law to smell, the object of
this paper is to offer a mass of experimental difference-deter-
minations, with a statement of the "checks" or controls to
which they must be subjected. . This enumeration of possible

errors involves a discussion of the essentials of a satisfactory olfactometric method, and a detailed description of the method and apparatus actually employed. The literature of difference-determinations in smell amounts practically to pages 180-181 and pages 188-194 in *Die Physiologie des Geruchs* of Dr. H. Zwaardemaker, now professor of physiology in the University of Utrecht. The work was translated into German from Dr. Zwaardemaker's manuscript by Dr. A. Junker von Langegg, and was published in Leipzig in 1895. The experiments to be described are in the main a realization of suggestions of Dr. Zwaardemaker's, of which some are contained in his book, and some few were made in personal letters. The olfactometric method used was, of course, his. This method was first applied in 1888, and is now familiar in most psychological laboratories. To quote from *Science*, XV, 44: "Dr. Zwaardemaker of Utrecht has constructed an instrument which he calls an olfactometer. It consists simply of a glass tube, one end of which curves upward to be inserted into the nostril. A shorter movable cylinder made of the odoriferous substance fits over the straight end of this glass tube. In inhaling,-no odor is perceived so long as the outer does not project beyond the inner tube. The farther we push forward the outer cylinder, the larger will be the scented surface presented to the inrushing column of air, and the stronger will be the odor perceived."

We are indebted to Dr. Zwaardemaker for the words "olfactometry" and "olfactometer" (replacing the older "osmometer"), "odorimetry" and "odorimeter." Olfactometry is that branch of psychophysics which is concerned with the measurement of the keenness of smell.[1] The distinction between the keenness and the delicacy of smell must be kept in mind. On the delicacy of smell depends the discrimination of olfactory qualities. On its keenness depend the bare sensing of odors and the discrimination of them as more or less intense.[2] Odorimetry is a "side-issue" of olfactometry. It is concerned not with the sense-organ, but with the measurement of the intensity of smell-stimuli considered as objectively as possible.[3] For the unit of keenness of smell, Zwaardemaker uses the word "olfactus," and for the normal stimulus-limen for each odorous substance he employs the companion word "olfacty."[4] If, for example, a subject's stimulus-limen on the olfactometer is 10 mm. when the normal stimulus-limen used is

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[1] *Die Physiologie des Geruchs*, p. 78.
[2] P. 11. *Cf.* also Vintschgau, *Die Physiologie des Geruchsinnes und des Geschmacksinnes*, in Hermann's *Handbuch der Physiologie*, III, 2, p. 270.
[3] Zwaardemaker: *op. cit.*, p. 174.
[4] Pp. 92, 134-135.

5 mm., then his stimulus-limen is two olfacties, and his olfactus
½. The olfacty used by olfactometry becomes for each sub-
stance the unit of odorimetry. Odorimetry is correlated with
photometry and phonometry. Both olfactometry and odorime-
try are branches of "olfactology" (to anglicise another word
used by Dr. Zwaardemaker). This again is correlated with
optics, acoustics and haptics.

The interdependence of olfactometry and odorimetry is not
unique. The unit of photometry, *i. e.*, the unit for the meas-
urement of light in the physical sense, is the illuminating
power for sensation of the light of some standard candle. "We
have no adequate objective method," writes Prof. Külpe, " of
ascertaining the intensity of the non-periodic and aperiodic
concussions which form the substrate of simple or complex
noises, independently of the statement of the observer whose
sensitivity we are testing. The phonometric determination of
sound intensities in psychophysical experiments is usually car-
ried out upon a principle similar to that employed in photom-
etry. As the objective stimulus-values in the apparatus em-
ployed,—say, elastic balls falling from a measurable height
on a resisting plate,—are determined by way of a subjective
comparison, the results are purely empirical, valid only for
the material used, the special circumstances of the observation,
etc."[1]

The peculiarly unsatisfactory character of the determina-
tions of olfactometry and odorimetry is due chiefly to the fact
that olfactory qualities, unlike visual and auditory, are not de-
marcated. It is true that it is more difficult to keep uniform
the duration and extension of smell-stimuli than it is to regu-
late these attributes for other stimuli, with the possible excep-
tions of temperature and taste. It is also true that the great
gulf of psychophysics, our ignorance of the physiological pro-
cesses which everywhere link the strictly physical to the psy-
chological, is wider in the cases of temperature, taste and
smell, than in the cases of vision, audition, pressure and strain.
Yet, at best, the measurements of physics must always be in
terms of sensation, and the measurement of sensation must
always be in terms of physics.

It seems wise to emphasize at the outset the initial difficulty
which makes all quantitative work in smell more or less un-
systematic, viz., the indeterminateness of olfactory qualities.
It is at present necessary to regard as a simple and separate
quality the odor of every substance which from a physical
point of view is unmixed ; yet, for several reasons, it is un-

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[1] *Outlines of Psychology*, tr., p. 156.

likely that there are as many elementary odors as there are simple substances.[1]

One reason is, that it is extremely improbable that either the structure of the fibres or endings, or the substance of the olfactory nerve, is differentiated to correspond to the innumerable odorous substances which we encounter; and, on the other hand, it is probable by analogy with other sense-organs, that there are "specific energies" of smell which are limited in number and capable of combination.[2]

A second reason is that we have experimental evidence that the action of the sense organ is differentiated into more and less separable processes. We have sure evidence in the results of exhaustion-experiments, which were first instituted by Frölich and Aronsohn.[3] For example, a subject whose organ is fatigued by the continuous smelling of tincture of iodine can sense ethereal oils and ethers almost or quite as well as ever, oils of lemon, turpentine and cloves but faintly, and common alcohol not at all. We have also evidence of some slight value in the recorded traces of partial anosmia.[4] Unfortunately, very few such cases have been described by persons who took experimental precautions, and such cases as are noted in medical literature fail to show typical anomalies comparable to the uniform phenomena of color-blindness or "tone-islands," which have played such an important part in the formation of theories of vision and audition.[5]

A third reason is that there are countless instances of smell-fusions in which the components cannot be detected. Nagel intimates that there is no proof of the existence of smell-fusions in which different components can be sensed as different at the same instant, and points out that, in this respect, smell-mixtures resemble color-mixtures rather than clangs.[6]

Zwaardemaker, following Aronsohn and bearing in mind the usages of the perfume trade, holds that only similar odors will

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[1] It should be noted that the words "simple" and "mixed" or "compound" are used here in the sense of physics proper, and not in the sense of chemistry. Smell, in the physical sense, is undoubtedly a property of the molecule, not of the atom. Indeed, most of the elements are odorless. Sulphur and hydrogen, themselves odorless, form sulphuretted hydrogen, one of the most offensive smelling gases known.

[2] Nagel: *Über Mischgerüche und die Komponentgliederung des Geruchsinnes. Zeitschrift für Psychologie und Physiologie der Sinnesorgane*, XV, pp. 82-83.

[3] Zwaardemaker: *op. cit.*, pp. 203, 204, 256-257. Aronsohn: *Untersuchungen zur Physiologi des Geruchs. Archiv für Physiologie*, 1886, pp. 342-346.

[4] Zwaardemaker: *op. cit.*, p. 259 sq.

[5] Nagel: *op. cit.*, p. 87.

[6] Pp. 90-91.

mix.[1]   He believes, on the basis of his own experiments, that
if dissimilar odors of different intensities are mixed, the weaker
odor will cancel part of the odor of the stronger, and will itself
be lost, and that if dissimilar odors of the same intensity are
mixed, both will disappear or will give but a feeble indetermi-
nate fusion.[2]   Zwaardemaker does not, as alleged by Nagel,
adduce his conclusions in regard to mixture as a buttress to
his localization and irradiation theory, though he does seek to
explain the facts of mixture and compensation, as he under-
stands them, in harmony with this theory.[3] Nagel, as opposed
to Zwaardemaker, believes, on the basis of his own experi-
ments, that any two smells will unite in a mixture which
for an instant, at least, will make a simple impression of
new quality.[4] He has never found an instance of complete
"compensation," but he agrees with Zwaardemaker that a
mixture of several smells is in general weaker than its indi-
vidual components, and that some combinations of strongly
odorous substances are almost odorless.[5]   Nagel offers no ex-
planation of the phenomenon of compensation, nor does
Zwaardemaker explain it satisfactorily even on the basis of his
irradiation-theory.   Perhaps it is safe to conclude that most
smells will mix.   As Nagel suggests, there is no occasion in
the perfume trade to mix nauseating or hircine smells with
the odors of flowers, spices and resins.

A fourth and final reason for believing that there are not as
many simple odors as there are unmixed substances, is that
many simple substances have been found by experiment to have
composite odors.   Chlorphenol and nitrobenzol are good ex-
amples of such substances.[6]

Now, if there are a limited number of specific energies of
smell, and if most smells are mixed, our ignorance of the ele-
mentary smells, and our consequent inability to isolate them,
have serious consequences for the value of olfactometric work.
This will be clearer if we consider the two methods which are
used to discover whether a smell is simple or composite.   The
method of Passy consists in gradually increasing the dilution of
odorous substances, and depends upon the principle that since
the stimulus-limina of different odors are different, they must
disappear successively as the intensities of the different stimuli
are diminished equally.[7]   However, it is at least possible that

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[1] *Op. cit.*, p. 280.
[2] Pp. 167 and 284.
[3] P. 279.
[4] *Op. cit.*, 95.
[5] P. 101.
[6] Pp. 96-97.
[7] P. 96.

odors which have very different stimulus-limina should have the same difference-limina. The other method is that of exhaustion, and depends on the fact that different odors exhaust the organ with different degrees of rapidity, so that a compound odor, continuously smelled, will alter in quality as first one and then another of its constituents disappears. One may smell continuously the substance to be tested, or may smell it before and after smelling repeatedly an odor very similar in quality. The principle of the method is the same in both cases. The permanency of the mixed odor depends primarily on the equality of rate at which its different constituents fatigue the organ. The more numerous the constituents, the more permanent the quality of the mixture. This fact is well recognized in the perfume industry. Fortunately for the trade, the odor of almost every flower (Sawer mentions jasmine as a unique exception)[1] may be simulated by compounding the odors of other flowers. The odor of violet, for example, is given by a blend of the odors of acacia, rose, Florentine iris, tuberose and almond. The odors of most flowers, again, are possessed by certain chemicals. To the mixture is usually added some substance, such as styrax, amber, or vanilla, which evaporates slowly, and smells strongly enough to compensate parts of the other odors. This is done that quantities of the other odorous substances large enough to allow for evaporation may be put into the solution without raising the intensity of the smell to the neighborhood of the terminal stimulus-intensity.[2] If, now, most smells are mixed, and if mixed smells alter in quality as the organ becomes fatigued, and if different olfactory qualities have not the same limina, then in quantitative work in smell, we are seeking to determine values which are continually changing according to laws which we do not know.

There is no classification of olfactory qualities, which is even provisionally satisfactory from any point of view but a perfumer's. We give to odors the names of the objects which most commonly give rise to them, or to something similar to them. We speak of a " fishy smell " as loosely as Homer, in the days when the terminology of color was in its infancy, spoke of " the wine-hued sea." Yet the name of an odor is clearly and indisputably applicable only to the smell of that object from which the name is taken.[3]

Giessler's classification of odors may be of value to psychology proper, but is of no value whatever to psychophysics.

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[1] Sawer : *Odorographia*, First Series, p. 94.
[2] Zwaardemaker : *op. cit.*, p. 285.
[3] P. 208.

The most satisfactory method of arriving at a classification of smells seems to be the method of exhaustion ; but the results so far obtained do not furnish any basis for such a system. Nagel points out as the greatest difficulty in the way that when the organ is fatigued by one smell, its sensitivity does not remain quite unimpaired for one large group of odors, and utterly fail for another group; but on the contrary, is usually more or less impaired for all odors.[1] Analysis by exhaustion is complicated experimentally by the fact that smells do not fall away steadily, but oscillate at the stimulus-limen, as do minimal sensations in other departments. In the case of smell this oscillation depends on slight variations in the rate and manner of breathing, as well as on the ordinary ebb and flow of the attention. The apparent "rivalry" of odors is due to this fluctuation at the limen.[2] Moreover, it is only the last component of the mixture to disappear, which is ever really isolated by the exhaustion-process.

Zwaardemaker adopts, with some modification, the old classification of Linnæus, which really has only a subjective basis, though Zwaardemaker attempts, without signal success, to give it a chemical one. On the principle that even a most unsatisfactory system is better than none, some pains have been taken in the experiments to be described to procure smells from as many of Zwaardemaker's classes as possible, and to compare results for representatives of the same class and of different classes. Zwaardemaker's classes of pure olfactory qualities are as follows :[3]

I. Ethereal smells—including all the fruit odors (a class taken from Lorry).

II. Aromatic smells—including all such odors as that of camphor, spicy smells, and the odors of anise and lavender, lemon and rose, and almond.

III. Fragrant smells—including the odors of most flowers, of vanilla, and of such gums as tolu and benzoin.

IV. Ambrosiac smells—including the odor of amber, and all the musk odors.

V. Alliaceous smells—including the odors of garlic, asafœtida, gum ammoniac, vulcanized India rubber, fish, bromine, chlorine and iodine, etc.

VI. Empyreumatic smells—including the odors of toast, tobacco smoke, pyridin, naphtha, etc., (a class taken from von Haller).

VII. Hircine smells—including the odors of cheese, sweat, rancid fat, etc., etc.

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[1] *Op. cit.*, p. 86.
[2] P. 98.
[3] *Op. cit.*, pp. 233-235.

VIII. Virulent smells—including such odors as that of opium, "Odor cimicis," etc.

IX. Nauseating smells—including the odors of decaying animal matter, of fæces and the like.

The pungency of smells is not an olfactory quality, but is due to the excitation of filaments of the trigeminus, which are freely distributed in the Schneiderian membrane. The sensation is more like pressure than smell. When very strong it becomes a tickling, and sneezing ensues. Persons who have congenital or pathological defects of smell are said to have cultivated these sensations by attention to such an extent that they do duty for smells proper.[1] Some smells which are not the flavors of food sensed in expiration, seem to be tastes, as well as smells. For example, we think of the odor of boiling syrup as sweet, and say that curdled milk " smells " sour. This is probably due to early association, which has indissolubly fused certain taste-memories with certain smell-sensations of peripheral origin.[2] It may, however, be due to the entrance of sapid particles through the nose into the pharynx.[3] Smells are often blended with pressure sensations other than pungency and with temperature sensations.[4] It is probable that there is an element of pain in an impression of pungency, while smells often give a " feeling of weight," pure and simple. Whenever the subjects in these experiments spoke of the heat, taste, pressure, pain, or pungency of an odor, their remarks were carefully noted, on the supposition that such factors in the total impression were disturbing in a quantitative investigation of olfactory qualities proper.

Zwaardemaker's differentiation of the specific energies of smell and localization of their actions on the olfactory mucous membrane is not to our present purpose. We may simply note in passing that he arranges the zones of their operation in horizontal order, since the height to which the air current is carried in the nose makes no difference in the quality of an odor ; and that he rather ingeniously places the nauseating and virulent smells farthest back and closest to the pharynx, in a region where they may excite the reflexes of vomiting and coughing by mere irradiation of nervous excitation without the connecting link of central processes; puts the hircine and ambrosiac odors in the middle, on account of the connection of hyperaemia of the " corpora cavernosa nasalia " with the blood supply of the generative organs ; and locates the fragrant, aromatic and ethereal smells farthest to the front, since the

[1] Pp. 236-237.
[2] P. 211.
[3] Pp. 211-212.
[4] P. 212.

sneezing-reflex is most easily excited in the anterior portion of the nasal cavities.[1] Nagel's remark that Zwaardemaker's localization-theory leads to "irresolvable contradiction" is not quite clear, but he is certainly right in saying that the theory has no adequate basis. Aside from the lack of experimental evidence, the arrangement of the several zones is too fancifully neat to carry conviction with it; but Zwaardemaker himself emphasizes the fact that the essential part of his theory is simply the arrangement of the operations of specific energies of smell corresponding more or less exactly to the classification of Linnæus on the olfactory mucous membrane in the order of these classes.[2]

Before bringing these introductory remarks to a close, it may be noted that, aside from any experimental evidence which may be offered, it is probable that Weber's law does apply to such smells, mixed and unmixed, as we daily encounter. In the first place we have the analogy of several other modalities of sensation for believing that the law applies to simple olfactory qualities. In the second place it has never been proved that Weber's law applies merely to unmixed sensations. It has been neither proved nor disproved for clangs, but many experiences of ordinary life would lead us to believe that it does apply to musical chords as wholes. Thus it may apply to smell-fusions as wholes, and approximately correct difference-determinations may be obtained for these wholes even while their character is gradually altering. Since, in the present state of our knowledge, no one can even pretend to be working with simple olfactory qualities, all difference-determinations in smell must proceed upon the assumption of this possibility. Experimental results must be the only decisive evidence for or against the theory, so that it is needless to discuss it farther in this place.

In the third place the distinction drawn by Passy between "insistent" and "intensive" smells, which is based upon a classification of smells in the popular mind and confirmed by other scientific men, is explained by the supposition that Weber's law applies to smell with different values of $\frac{\Delta r}{r}$ for different qualities. In Zwaardemaker's language, and in the ordinary language of this paper, the smaller the "minimum perceptible" of a substance, the more intense its odor. Passy uses a term, "pouvoir odorant,"—which we may translate "insistency,"—for "intensity" in our sense. He says : "Tout le monde sent que le camphre, le citron, le benzine sont des odeurs for-

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[1] Pp. 262-265.
[2] P. 265.

tes, la vanille, l'iris des odeurs faibles," though vanilla has an insistency one thousand times greater than that of comphor. Besides this subjective basis of distinction between weak odors, however insistent, and strong or intensive odors, he has five objective differentiæ. (1) Weak smells have vague differences of intensity. For example, vanilla and coumarine soon reach a maximum of intensity which cannot be increased. Greater concentrations simply become unpleasant. (2) Individual differences are more evident for weak smells. (3) The daily variations of sensitivity are more evident for weak smells. (4) Exhaustion has more effect on weak smells. (5) Strong smells hide the weak.[1] In view of the first objective difference, Zwaardemaker explains the subjective difference as follows : As the strength of a sensation is estimated by the number of grades of intensity by which it surpasses the liminal sensation, and as the terminal stimulus is by definition that degree of intensity beyond which increase cannot be shown for our human sense organs with our mechanical appliances, it is obvious that odors with large difference-limina must be subjectively weak, and that subjectively weak odors must have large difference-limina. Thus, the very rapid attainment by some smell-stimuli of the terminal intensity would seem to indicate that Weber's law applied to olfactory qualities, and that the difference-limen differed from quality to quality.[2]

Unfortunately our own experimental results are at variance with the second clause of the theory. They make Weber's law appear to apply to smells as we find them, but show no great variation of $\frac{\Delta r}{r}$ from substance to substance. The difference-limina even of camphor and vanilline seem much the same. If our figures are accepted as trustworthy, some other explanation than the simple one of Zwaardemaker must be found for the distinction of Passy. May it not be that, for phylogenetic reasons, " intense" smells have more affective value, more of what Müller calls " Eindringlichkeit,"[3] than have the smells which Passy calls " insistent ?" Or may it not be that the smells most useful to human life exhaust the human sense-organ less after many increments than smells less useful do after a few increments, although the increments are relatively equal throughout ? The need of some such explanation will be more or less clear as the figures to be offered are more or less convincing.

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[1] Pp. 191-192.
[2] Pp. 192-193.
[3] The " Eindringlichkeit" of a sensation depends in part upon its intensity, and in part upon its affective value (G. E. Müller, Zeitschr. f. Psych. und Physiol. der Sinnesorgane, X, pp. 25-27).

CHAPTER I.   METHOD.

Section 1.   Determination of the intensity of the Smell-Stimulus
for the Normal Organ.

If all the nervous elements concerned in smell are in a nor-
mal condition, and if "compensation" does not come into play,
the intensity of an odor depends on the number of odorous par-
ticles in gaseous form which are acting on the olfactory nerve-
endings at the time.   Perhaps it is safe to say that the intensity
is ordinarily a function of the number which are acting on the
rod-cells of the olfactory mucous membrane.[1]   Whether or not
individual rod-cells are subject to cumulative stimulation, we
do not know, for we do not know even whether the stimulation
is chemical, thermal, or electrical,[2] but we do know that the
intensity of the smell seems to depend on the extent of mem-
brane and therefore on the number of rod-cells stimulated,—
always supposing that the rod-cells are the olfactory cells proper.

Now the number of odorous particles which act at any given
time on the olfactory membrane of the normal nose depends,
first, on the quantity of vapor which the fragrant body is
throwing off; secondly, on the rate of the diffusion of this
vapor; and thirdly, on the manner and rate of breathing.   Let
us consider these facts separately.

I.   *The Quantity of Vapor Thrown off by the Odorous
Body.*   "Whether" says Zwaardemaker, "odorous particles
are set free by evaporation or chemical reaction, the mass of
odorous molecules which are given off from a solid body or the
surface of a liquid is, *ceteris paribus*, in compound proportion
to the time of exposure and extent of surface exposed.[3]
Zwaardemaker has invented a "genetic unit" for the measure-
ment of odor in the physical sense.   It is the number of seconds
of exposure multiplied by the number of square millimeters of
surface exposed.[4]   It is unnecessary to say that the genetic
unit differs from substance to substance.   The "other factors"
which must remain equal, if the genetic unit of a given sub-
stance is to be constant, are the moisture, weight, and temper-
ature of the atmosphere and the amount of ozone present in it.[5]

That heat and dampness affect the intensity of odors is a
matter of common observation.   Yellow wax smells twice as
strong in summer as in winter.   Heat promotes evaporation.
Dampness also promotes the vaporization of such solids as are

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[1] Zwaardemaker : *op. cit.*, p. 7; Foster: *Text Book of Physiology*,
6th ed., p. 249.

[2] Zwaardemaker : *op. cit.*, pp. 276-277.

[3] P. 39.

[4] P. 26.

[5] P. 28.

soluble in water, but, on the other hand, retards the diffusion of odorous vapors. The temperature of the laboratory in which smell experiments are in progress should be kept as uniform as possible, and thermometer and barometer readings should be taken whenever the stimulus-limen is determined. Uniformity of temperature was not secured in our own experiments.

II. *The Rate of Diffusion of Odorous Vapor.* Cloquet pointed out in 1821 that odors diffuse in the air as one gas diffuses in another,—gradually, and without interruption by reflection or refraction, —so that if the air is at rest, the strength of a smell will be inversely proportional to the distance of its source, though the speed with which different odors travel varies much.[1] Now the air from which we draw our breath is, under ordinary circumstances, almost never free from currents. For phylogenetic reasons, no gas is odorous which is not heavy enough to remain near its source if undisturbed. Yet the wind may carry such gases for miles near the surface of the ground. Nor can we, in view of the dynamic theory of smell, and of Liegois's theory that odorous particles are largely diffused in the form of tiny liquid drops which afterwards vaporize, unhesitatingly apply the laws of diffusion of gases to smells. Zwaardemaker has, however, proved by a series of experiments that the transmission of odorous vapors in tubes takes place at the same rate for different distances from the source, unless these distances are very considerable.[2] From an inhaling-tube, all currents of air, except the suction-current created by the inspiration, are excluded.

III. *The Rate and Manner of Breathing.* Not all the air which passes through the nose comes in contact with the olfactory mucuous membrane. The current of air drawn into the nose from without is divided by the lower turbinal bone into two portions. From the stream which takes the direct path to the choana under this bone and along the floor of the nose, no odorous vapor reaches the olfactory membrane. Each nasal cavity is divided by the middle turbinal bone into two chambers. In the upper chamber, which extends from the pointed roof of the nose to the under edge of the middle turbinal bone, the side wall and the septum are almost parallel, and only about two millimeters apart. The olfactory membrane is spread over the upper surface of these parallel walls, forming the *regio olfactoria* of Todd and Bowman. According to von Brunn only the uppermost part of the upper turbinal bone and the surface of the septum just opposite are covered by the ol-

[1] P. 30.
[2] Pp. 31-34, 39-40.

factory membrane.[1] In ordinary breathing, the highest point
in the upper stream is, according to Franke, the under edge of
the upper turbinal bone, and according to Paulsen and Zwaar-
demaker, the under edge of the middle turbinal bone.[2] In the
rapid and violent breathing with expanded nostrils which we
call " sniffing," the air is carried about 2 mm. higher,[3]—i. e.,
into the forward and under part of the upper chamber. In
either case, odorous particles can reach the olfactory membrane
only by diffusion, but more of them will penetrate to it in
sniffing than in quiet inspiration. The upper chamber is an
annex, not an integral part, of the breathing-passage.

Odorous particles probably do not accumulate in the upper
chamber. During inspiration, the air in the passages traversed
by the current is thinned, and as soon as inspiration ceases, the
air in the upper chamber rushes down to the middle meatus, to
be renewed from the pharynx during expiration.[4] If so much
odorous matter has been taken in as to saturate the air in the
pharynx, we sometimes get a smell in expiration even when
we are not eating. Ordinarily, however, the very weak stimu-
lus from the pharynx, coming after the very strong stimulus
from without, is not sensed.[5] Fick, indeed, advanced the hy-
pothesis that when odorous particles come in contact with the
olfactory membrane, they are at once dissolved in the thin fluid
which covers the bottom of the sensitive hairs, and that when
so dissolved, they cease to act.[6] These particles may, how-
ever, accumulate to some extent on the Schneiderian mem-
brane, especially, if it is in a catarrhal condition. Of course,
we get the flavor of food only in expiration. The course of
the air in expiration is almost the same as in inspiration, but
Bidder is probably right in supposing that a smaller amount
passes above the lower turbinal bone.[7]

Under ordinary conditions, the more rapid the breathing, the
more intense the smell. Sniffing is to be forbidden in olfacto-
metric work, not merely because it carries the air higher in the
nose, than does " regular breathing," but because, both by in-
creasing the suction-force and by widening the entrance, it
takes more air and therefore more odorous particles into the
nose in a given time. The spaces from which air is drawn
through the nose are cones with their points at the nostrils.
We may see their size and shape in the clouds of vapor formed

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[1] P. 6.
[2] Pp. 46-57, 67.
[3] P. 202.
[4] P. 60.
[5] P. 62.
[6] P. 60.
[7] P. 42.

by our exhalations in cold weather. The spaces from which
odorous particles are drawn are portions of these larger spaces.
The breathing-spaces are projections of the whole of the nasal
cavities; the "fields of smell" are projections only of those
cavities from which odorous particles reach the olfactory mem-
brane. They are separated from each other by about a centi-
meter. In sniffing, through the expansion of the nostrils, the
fields of smell become wider than the ordinary breathing-spaces,
but as the inspiration is short and quick, they are not so deep.[1]

If then the strength of a smell-stimulus is to be measured
with some degree of accuracy by the genetic unit, the tempera-
ture and moisture of the air, the diffusion-rate of the vapor,
and the subject's manner and rate of breathing must be kept
as uniform as possible.

As for the compensation-error, there is no intrinsic stimula-
tion of the olfactory membrane as there is of the retina and the
ear. Owing to exhaustion, the subject cannot smell his own
breath in expiration. He can indeed smell it in inspiration if the
current is puffed upward to the nostrils. This fact seems to
show that, given the same amount of odorous matter in the air
current, we get a stronger smell in inspiration than in expira-
tion. On the other hand, the difficulty of securing an absence
of smells from external sources for a subject who has at all
cultivated his organ by attention, transcends the difficulty of
securing such silences and darknesses as are satisfactory for
experimental purposes. Of course, no substance which, *as such*,
is to be used as a test, should be dissolved in an odorous
medium, such as alcohol, ammonia, or ether.

Zwaardemaker classes the methods which have so far been
employed to find the stimulus-limina of smells as direct and
indirect.[2] By the direct methods the subject seeks to find the
stimulus-limen of an olfactory quality in terms of the greatest
dilution of an odorous vapor which can give a just noticeable
sensation of that quality. By the indirect methods, he seeks
to find the stimulus-limen in terms of the smallest quantity of
the odorous substance which can be sensed under certain defi-
nite and easily procurable conditions. The direct methods aim
at absolute results where absolute results are unattainable.
"It may be possible," says Zwaardemaker, "to determine the
area of an inspiration made in an effort to smell, but the exact
ascertainment of the amount of odorous gas which in this in-
spiration comes in contact with the olfactory cells has so far
proved an impossibility."[3] The indirect methods aim at rela-
tive results, but their procedure is exact. They furnish a

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[1] Pp. 68-77.
[2] Pp. 79-80.
[3] P. 80.

basis for the comparison of individuals with reference to their keenness of smell, and of substances with reference to their value for the sense, and thus may indirectly lead to some knowledge of the greatest degree of dilution in which an odorous substance can be detected.[1]

The method which Valentin invented in 1848 may be called classical, since it is mentioned in most of the standard text books of physiology. It was direct, and consisted in taking a certain volume of odorous gas and mingling it with a hundred volumes of air, taking a certain volume of the mixture and mingling this again with a hundred volumes of fresh air, and so on until the last mixture gave a just discernable odor. Valentin varied his procedure by allowing the vaporization of smaller and smaller quantities of a highly concentrated solution of an odorous substance in a definite amount of air, or by mingling smaller and smaller quantities of it with a mass of water of a given volume.[2] It is plain that a certain amount of the odorous substance must adhere to the vessel in which such a mixture is contained, so that the amount of odorous substance taken away from the receptacle for a new admixture will never be so large as the ratio of the gas or liquid removed to the whole volume would indicate, and that this error must increase as the experiment proceeds. As for the use of highly concentrated solutions, it involves two serious disadvantages, the blunting of the sense by exhaustion and the adhesion of odorous particles to objects in the laboratory.[3]

The invention of no other direct olfactrometric method is recorded before that of the method employed by Fischer and Penzoldt in 1887. Avoiding Valentin's progressive dilutions, these investigators sought to determine how much mercaptan and how much chlorphenol must be introduced into the whole mass of air in a laboratory of a certain size in order to give an odor just noticeable to a person entering the room. The walls of the laboratory were perfectly smooth, the floor was of stone, and the equal distribution of the odorous gas to all parts of the room was secured by the motion of fans. The solutions were scattered with a fine spray.[4] Unfortunately, these solutions were alcoholic.

In the same year H. C. Dibbits arrived at a partial determination of the stimulus-limen for the odor of acetic acid. Acetate of zinc is decomposed in the presence of water, and an insoluble basic salt and free acetic acid are formed. Dibbits, during the course of sixteen hours, allowed 60 litres of damp air to pass over a mass of salt which had been freed from water of crystallization, found the loss of weight to be 16.8 mg., and calculated the proportion that the weight of the acetic acid set free must bear to this loss of weight to be $\frac{2}{5}$. As 24 mg. of acetic acid must have been communicated to 60 l. of air, and as the odor was discernible in this air, the stimulus-limen of acetic acid must lie under 0.4 mg. per litre.[5] While the methods of Fischer and Penzoldt and of Dibbits are comparatively accurate, it is obvious that they are impracticable for difference-determinations.

A method employed in 1889 by Ottolenghi for testing the olfactory sensitivity of criminals is a modified form of Valentin's, and is essentially the same as the method recommended by Passy in 1892.

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[1] P. 80.
[2] Valentin: *Grundriss der Physiologie*, p. 515.
[3] Zwaardemaker: *op. cit.*, p. 79.
[4] *American Journal of Psychology*, I, p. 357.
[5] Zwaardemaker: *op. cit.*, p. 84.

Ottolenghi used 12 aqueous solutions of essence of cloves contained in similar bottles in similar quantities. The solutions were graduated from 1: 50000 to 1:100. The subject began with the weakest solution and took the bottles successively until sensation commenced. Passy dissolved a certain weight of odorous material in a given weight of alcohol, mingled a certain fraction of the solution with a given weight of pure alcohol, and so on, until he had obtained a graduated series of saturations. He then put single drops of his solutions into bottles of the same size, and arrived by the method of just noticeable stimuli at an estimate of the stimulus-limen in terms of saturation-strength and the area of his bottles.[1] Ottolenghi's combinations of essence of cloves and water were not true solutions. Passy's results are vitiated by the compensating effect of the odor of the alcohol. Both methods involve an error due to the constant loss of odorous material by the mere opening of the vessels for the subject to smell their contents, by inhalation, and by condensation on the walls of the vessels. Zwaardemaker suggests that fairly satisfactory results might be obtained on Ottolenghi's principle if one (1) employed only solutions in distilled water, (2) made very short inspirations, (3) used very large inhaling vessels, and (4) avoided all odorous substances the vapor of which is easily condensed.[2] Theoretically, if the series of saturations could be minutely enough graduated, this method might be employed for difference-determinations, but practically, the use of many large inhaling-vessels would make it too clumsy.

The first indirect method was invented by Frölich in 1851, three years after Valentin invented his direct method. Frölich gauged the keenness of smell by the distances at which odorous substances could be sensed under uniform conditions. He put up in tightly corked test-tubes such substances as ethereal oils, resins, spices, and musk mixed with starch in such proportions that however different in quality, the odors might be the same in intensity. The subject closed his eyes, the tube was uncorked and moved toward him, and both the distance at which the substance was first sensed and the time at which judgment was passed were marked.[3] Frölich seems, however, to have made little use of his time-estimates. As the odors with which he worked are slowly diffused, the mass of odorous vapor may be thought of as moving with the tube. Yet results based on such a rough hypothesis cannot be very reliable.[4] Moreover, the assumption that odors so unlike in quality are of the same intensity, since they can be just sensed by the same person at the same distance, begs the question of the value of the hypothesis mentioned, and Frölich seems to have had no other means of determining their comparative intensity except guess-work.

Aronsohn's famous method, devised in 1886, though indirect upon the ordinary theory of smell which makes the odorous particles act in gaseous form on the olfactory membrane, must be classed on Aronsohn's own premises as direct. His hypothesis is that odorous particles are in solution when they act on the nerve-endings. This assumption, for which J. Müller is chiefly responsible,[5] is based (1) on the fact that fishes and amphibia have peripheral and central organs similar to the organs of smell in birds and mammals, and (2) on the fact that the nasal membranes are normally covered with mucus,

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[1] Pp. 98-99.
[2] P. 99.
[3] Pp. 80-81.
[4] P. 81.
[5] P. 62.

and that the drying of this mucus, as in the first stage of rhinitis, impairs the sense of smell. Tortual and Weber had indeed proved that odorous liquids when introduced into the nose " do not smell," and Weber had also found that the sense is for a time impaired if warm or cold water or sugar and water are poured into the nasal cavities and retained there for a few moments.[1] Aronsohn explained these phenomena by supposing that strong solutions of odorous matter and liquids of foreign temperature if brought in contact with the delicate olfactory membrane must necessarily have a pernicious effect. He found, on the other hand, that very small quantities of odorous substances dissolved in normal saline solutions can be sensed if the mixture, at a temperature of about 40° C., is poured into the nose from the height of about half a meter. Weber had used cologne and water in the proportion of 1 : 11. Aronsohn used oil of cloves, for example, in salt and water in the proportion of 1 : 500. His olfactometric method consisted simply in determining how weak a solution of an odorous substance could be sensed if injected at the temperature proved empirically to be most favorable for its detection.[2] If Aronsohn's premises are correct, not only is his method direct, but the worst difficulties in the measurement of smell-stimuli are eliminated. In criticism of these premises, however, Zwaardemaker points out (1) that aquatic mammals have organs which resemble the organs of smell in land mammals, but are rudimentary, as if useless under water ; (2) that the dryness of rhinitis is confined almost exclusively to the Schneiderian membrane and is conjoined with hyperaemia and swelling which obstructs the passage of air; (3) that the cilia of the olfactory cells protrude through the covering of mucus; and (4) that most odorous substances are not at all or are but very slightly soluble in water. Books on the perfume-industry are filled with the discussion of ethereal oils, of spices, gums, and the like. In a room saturated with perfume or tobacco smoke, a bit of cotton wool will take up the odor, while a glass of water will not. Moreover, as Zwaardemaker believes, it cannot be shown that Aronsohn succeeded in filling the cavity which contains the olfactory membrane so entirely with liquid that all bubbles of air were excluded. It is very difficult to drive all the air out of blind pouches.[3]

In 1893, Dr. N. Savelieff in the laboratory of Morokschowetz constructed an olfactometer on a principle entirely different from Zwaardemaker's. There were two flasks of glass, each with two corks. Through one cork in each, the two flasks were connected by a glass tube bent twice at right angles. Through the other cork of one was inserted a glass tube which reached to the bottom. Through this tube a mixture of ethereal oil and water was poured. The liquid did not reach the end of the connecting tube. Through the remaining cork of the second flask, which was filled only with air, was inserted a glass inhaling-tube which divided into a nose-piece for each nostril. The odor of the liquid was weakened by successive additions of water, and the intensity of the stimulus was measured through the proportion by weight which the ethereal oil bears to the water.[4] As Zwaardemaker suggests the method of Savelieff has this great disadvantage, that its results do not stand in simple relations to the real stimulus-intensities. The intensity of the stimulus will vary according to the height of the liquid in the first vessel, and according to the ad-

[1] Weber: *Archiv f. Physiologie,* 1847, p. 351-354.
[2] Aronsohn : *op. cit.,* 1886, pp. 324-332.
[3] *Op. cit.,* pp. 62-66.
[4] *Neurologisches Centralblatt,* 1893, p. 343 sq.[4]

hesion of odorous material in different parts of the apparatus. Sav-
elieff's method would indeed be fairly satisfactory for clinical pur-
poses if real solutions were used instead of mixtures of ethereal oils
and water. It is a great disadvantage, however, to begin an experi-
ment by exhausting the sense-organ with a saturated solution.[1]

*Section 2.   Control in Zwaardemaker's Olfactometric Method of
the Factors which Determine the Intensity of the Stimulus.*

Zwaardemaker's measurements of the smell-stimulus are in
terms of but one factor of the genetic unit,—viz., in terms of
the amount of odorous surface exposed. The time for which
different extents of surface are exposed is supposed to be kept
constant by the regularity of the movement of the hand which
manipulates the odorous cylinder. All of these time-values
are so small that their variation may well be disregarded.

In 1890, Henry, a French scientist, instituted in the interests of the
perfume industry a modified form of Zwaardemaker's method, and
took the time values into account. His instrument differs from
Zwaardemaker's only in the substitution for the odorous cylinder of a
porous paper cylinder, hollow, closed at the bottom, and saturated
from a surrounding glass reservoir with the fumes of an odorous
liquid. The glass inhaling-tube enters from the top, and the subject
raises it with a uniform movement while he is making the inspiration
required. Stimulus-intensity is reckoned in terms of the surface of
the paper cylinder exposed, and of the time which the odorous vapor
has had for diffusing into it since the lifting of the inhaling tube.[2]
As for this second factor, by which alone Henry's method differs from
Zwaardemaker's, Passy suggests that the time-rate of evaporation of
a liquid under a membrane differs from the time-rate of the same fluid
in the open air. Henry supposes that the pressure of vapor on the
paper cylinder is constant, but on the contrary, since its surface is
wholly covered at the beginning of the experiment and is gradually
uncovered as the glass tube is raised, the pressure of vapor will con-
stantly decrease.[3] At any rate, Henry's apparatus will not answer for
difference-determinations, as it would render procedure in both direc-
tions impossible.

Much more serious in Zwaardemaker's method than any
error which may arise from irregularity in the subject's move-
ments is the error due to the adhesion of odorous particles in
the glass inhaling-tube. These particles may condense on the
sides of the tube or, if the substance is soluble in water, may
dissolve in the moisture which forms on the inside during in-
spiration. A correction can be made for adhesion only for the
"minimum perceptible," and only for a determination taken
with the perfectly dry and clean inhaling-tube and a saturated
porcelain cylinder. It may be made as follows : Let the
length of the inhaling-tube ordinarily used be x and let a be
the value of the stimulus-limen as found with it. Then let a

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[1] *Op. cit.*, pp. 100-101.
[2] *Comptes rendus de l' Academie des Sciences*, Feb. 9, 1891.
[3] Zwaardemaker : *op. cit.*, p. 94.

shorter inhaling-tube of the same diameter and the length y be
pushed for about 2 mm. into the odorous cylinder.   Through
the other end of this cylinder, which is usually the movable
part of the instrument, let a third tube of the same diameter be
pushed.   By moving this third tube backward and forward,
the extent of odorous surface exposed to the air is varied.   Let
the stimulus-limen found under these conditions be b.   Then
$a - b$ will be the difference in the stimulus-limen made by the
adhesion of odorous particles to a tube of the length $x - y$.
The correction to be made for adhesion to a tube of the length
x will be as much greater as x is greater than $x - y$.   If cylin-
ders of solid odorous substances be used, this correction cannot
be made, even for the stimulus-limen, since it is so exceedingly
small.   It is impossible, moreover, to take many determin-
ations even of the stimulus-limen in an hour with a perfectly
dry and clean tube.   As for the difference-limen, it is both
theoretically and practically impossible to make the adhesion-
correction, for to know how much greater for sensation a
given stimulus is than the liminal stimulus, one would have
to know beforehand that Weber's law applied to that particular
olfactory quality, and what the exact value of $\dfrac{\Delta r}{r}$ for the quality

was.   The effect of adhesion, in the first inspiration or at
least in the very first few inspirations, is to decrease the
strength of the stimulus, but after the first or at most after the
second or third inspiration, the effect is rather to increase
the strength of the stimulus, since the odor from the matter
adhering to the inhaling-tube more than compensates for the
loss of the odor of the matter which continues to adhere.

The tube must be carefully dried after it has been washed,
and the subject must be trained not to breathe back into it.
Yet on a damp day, the moisture left on the inside of the tube
by the inspired air is no inconsiderable source of error.   Bun-
sen computes the possible thickness of such a layer at 0.00101
mm.   If a glass tube is 15 cm. long and 5 mm. wide, the area
of its bore will be 23.57 qmm.   This would make the weight
of a layer of moisture of the thickness given by Bunsen 2.38
mg.   If the odorous substance is in aqueous solution, this
moisture may be left out of account, but if no moisture comes
from the cylinder itself, it may vitiate the results of the experi-
ment.   Since the dampness of the air varies from day to day,
this error cannot well be corrected.[1]   All that one can do is
faithfully to take the barometer-readings in the hope of finding
in them possible explanations of erratic judgments.   The ex-
perimenter must be careful to cool the inhaling-tube after dry-

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[1] Pp. 124-125.

ing it over the spirit-flame, not only on account of the risk of
distracting the subject's attention with a warm tube, but on
account of the danger of heating the inside of the odorous
cylinder.

Since the source of the odorous vapor is connected with the
subject's nose by a tube of known length, the diffusion of the
matter is, outside of the body, obviously under complete control.

The subject's breathing is, indeed, a seriously variable element,
but its variation is by no means the greatest practical draw-
back to the method. Sniffing must, of course, be watched for
and peremptorily forbidden. The mere expansion of the nos-
trils does not increase the intensity of the odor as it does under
ordinary circumstances, but rather decreases it, since the field
of smell is artificially limited, and the widening of the en-
trance to the nose simply increases the amount of air which
dilutes the odorous gas. Under ordinary circumstances, as we
have seen, the more rapidly one breathes, the stronger the
odor one will get. If one uses the olfactometer, this is not
true. Since the diffusion-rate within the cylinder is constant,
increased rapidity of breathing will increase the degree in
which the odorous particles are diluted with air on their en-
trance to the nasal passages. Thus, the more slowly one
breathes, within a certain limit, the stronger the smell one will
get. The air must be drawn in with enough force to carry part
of the current above the lower turbinal bone. If the air simply
takes the straight path to the choana along the floor of the
nasal cavity under the lower turbinal bone, there will be no
smell. Zwaardemaker believes that each subject with a little
practice will discover for himself the best rate of breathing for
obtaining the strongest smell from a given stimulus, so that, in
a manner, the breathing rate will be self-regulating.[1] Our
own experimental results seem to bear out this conclusion. In
Section 1 of Chapter III, each subject's mode of breathing is
noted, but its peculiarities can scarcely be traced in the
numerical results. The inability of most of the subjects to
arrive at difference-determinations with one inspiration must, of
course, have aggravated the adhesion-error. Henry regulates
the breathing of his subjects by putting about the chest a belt
which allows only a certain expansion. Such an appliance
must, however, have the effect of distracting the subject's at-
tention and making the breathing unnatural. Following
Zwaardemaker's example, we did not even stop the nostril not
in use. The inhaling-tube was thrust into the forward[2] half
of the nostril to the depth of half a centimetre.

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[1] Pp. 86-87.
[2] A substance pressed against the back of the nostril can hardly be
smelled at all, as its vapor will take the direct path to the choana.

We may say, then, that the most unsatisfactory features of
Zwaardemaker's method are (1) the adhesion-error, and (2) a
tendency which the subject, if he manipulates the odorous
cylinder, has toward judging in terms of hand-movement.
This difficulty will be discussed in another place.

While the intensity of the stimulus depends in the case of
any sense upon the condition of the peripheral organ, no sense-
organ is so likely to vary either through obstruction or through
exhaustion as is the organ of smell. Let us now consider the
variations from the normal condition to which this organ is
most subject.

Section 3.   Anosmia and Hyperosmia.[1]

Whether pathological or non-pathological in origin, anosmia
is of three sorts,—respiratory, essential or toxic, and nervous.
Respiratory anosmia is due to obstruction of the nasal passages,
from asymmetry of the nasal skeleton, from hyperaemia of the
respiratory or Schneiderian membrane, or from accumulation of
mucus. Toxic anosmia may be due to poisons in the inspired
air,—a form not yet investigated,—to injurious fluids introduced
directly into the chamber containing the sense-epithelium (as
in Aronsohn's experiments), to poisons, such as morphine,
pulverized and blown into the nose, or to certain forms of
blood-poisoning, such as chronic nicotine-poisoning. The
anosmia of smokers cannot be wholly attributed to their
catarrh, though a light, acute nicotine-poisoning does not
seem to produce a loss of smell. Nervous anosmia may be
congenital,—i. e., due to imperfect development of the olfac-
tory vesicle in the brain,—or may be senile,—due to degenera-
tion of some of the nervous elements which condition the
sense,—or may be due to exhaustion of the olfactory nerve,
or to dryness of the epithelium. If we rule out exhaustion, we
may say that respiratory anosmia is vastly more common than
toxic or nervous. The more peripheral parts of every sense-
organ are more subject to injury and disease. Thus, the mus-
cles and lenses of the eye give much more trouble than the
retina and the optic nerve. In the case of smell, the sensory
epithelium is well protected by its secluded position.

As to hyperaemia of the respiratory mucous membrane, its
blood supply is controlled much more by the exigencies of
breathing than by those of smell. It is largely under the sway
of local reflexes. The fibers of the trigeminus which ramify
through it are closely connected with fibers of the sympathetic
nervous system. Too profuse secretion of mucus is the most
common mechanical hindrance to smell. On the other hand,

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[1] Pp. 136-165.

too small a secretion has a disastrous effect on the sense-epithelium. It seems that the tiny hairs of the rod-cells re-fuse to do their work if they become dry. The action of all the mucous glands of the nose may be increased by injecting strychnine, and decreased by injecting atropin into the membranes. Too much atropin, however, produces irritation and a flow of tears.

Hyperosmia may also be respiratory,—due to certain asymmetries of the skeleton or to anæmia of the respiratory membrane,—or toxic, or nervous. In hysterical subjects, hyperosmia is common. Anæmia of the respiratory membrane may be produced by smelling such substances as cocoa-butter, or cedar-wood, which rather powerfully affect the trigeminus.

The two forms of anosmia, which vary in the same subject from day to day, are respiratory anosmia from obstruction of the nasal passages by mucus, and nervous anosmia from exhaustion. It is possible at any time easily to discover whether the nasal passages are obstructed or not. The test can be made by ex-haling on a concave metal mirror held at the level of the mouth. The clouds of condensed vapor give the true shape of transverse sections of the breathing-cones. They are divided from each other, and if the nasal passages are in a normal con-dition, they are symmetrical, and broader than they are long. As they pass away, they should each divide into an antero-medial and a postero-lateral division of about the same size. As divided, the spots should still be roughly symmetrical. The division is due to the projection of the " triangular cartilage " and the lower turbinal bone from the side wall of the nose. This division of the air current occurs in all mammals.[1] Patho-logical alterations in the mucous membrane of the nose and asymmetry of the nasal skeleton may alter the size and shape of these divisions, but rarely prevent them from appearing. The antero-medial division alone represents the current of air which passes above the lower turbinal bone. The form and position of the field of smell in an ordinary inspiration, there-fore, corresponds roughly with this division, and would do so exactly if it were not for the slight difference in the course of the currents of inspired and expired air.[2]

The influence of exhaustion is more insidious. It varies from subject to subject, from substance to substance, and from one intensity of a substance and one general condition of a sub-ject to another, so that numerical corrections are out of the question. Fortunately or unfortunately, the effects of adhe-sion and exhaustion are for the most part opposite. This

[1] P. 73.
[2] Pp. 73-74.

opposite influence makes one's numerical results more nearly
correct than they would otherwise be.   On the other hand, it
makes the exact influence of each source of error more difficult
to read from the figures.   Yet it is not particularly difficult to
detect the effect of the exhaustion when it is at all marked, and
to exclude the most unreliable determinations.   In our expe-
rience of thirteen different subjects, complete or marked
anosmia from exhaustion, if it occurred at all, usually came on
very suddenly.

Section 4.   Psychophysical Methods Employed.

Before difference-determinations were made at all, the stim-
ulus-limen was usually found as accurately as possible for the
substance and subject concerned.   The subject, starting with
the end of the odorous cylinder even with the end of the inhal-
ing-tube, moved the cylinder outward until he obtained a smell.
If this smell seemed to him more than liminal, he moved the
cylinder back for a short distance, and continued to move back-
wards and forwards until he had satisfied himself as to the point
at which he obtained a just noticeable sensation.   The method
of moving steadily in both directions,—from a point considera-
bly below to a point just above the limen, and from a point con-
siderably above to a point just below the limen,—was tried, but
was abandoned.   It is often impossible, on account of adhesion
in the tube or in the nasal passages, or on account of memory
after-images, or cumulative stimulation, to move from a point
of intensive stimulation to a point at which sensation entirely
disappears.   Memory after-images certainly occur.   The exist-
ence of true after-images of peripheral origin has not been
proved in the case of smell.[1]

The only difference-determinations for smell, so far on record,
are a few which Zwaardemaker performed for yellow wax and
vulcanized rubber.   The method which he employed, and the
method which so far seems practicable, is Fechner's rough and
simple method of just noticeable differences.   One gives the
subject a standard stimulus, and then after an interval, which
one makes as nearly uniform as possible, a second stimulus
which is appreciably greater or smaller.   He himself then
moves the cylinder until he makes the stimulus just greater
or just smaller than the standard.   When in the neighborhood
of the stimulus, he moves back and forth as he likes, until he
has satisfied himself of the accuracy of the determination.
Thus, as there is near the limen procedure in both directions,
the method may be classed as a gradation-method.   The in-
terval between the two stimuli averaged in our experiments $2\frac{1}{2}$

[1] P. 260.

seconds with the standard olfactometer, and 5 seconds with the fluid-mantle olfactometer. With the small olfactometer, it was never less than 2, and almost never greater than 4 seconds. It was ordinarily 2. With the large olfactometer, it varied from 4 to 6 seconds. The difficulty in manipulating the large olfactometer more quickly will be described in another place. The interval between determinations was much more variable. It was usually about a minute, except when the tube was cleaned. Our determinations were broken into short series in which Δro and Δru were found alternately. The series were divided from each other by the necessary cleanings of the inhaling-tube. With some substances, we washed and dried the tube after every 8 determinations, wiping it out with dry absorbent cotton in the middle of the series. With other substances, we washed and dried it at the end of every 4 determinations. It took about a minute to give the tube a dry wipe, making the interval between half series about 2 minutes. After practice, it took about 3 minutes to wash, wipe and dry the tube, making the interval between series about 4 minutes. These time estimates are all rough. We were not intent on time-determinations; the subject had often incidental remarks to make on his own experiences; and there were various untoward accidents,—water spilled, tubes broken, wire dropped, etc. The subject used his two nostrils alternately; all our records were kept for the two nostrils of each subject as for two different persons. We changed the order of determinations in successive series that exhaustion and adhesion might equally affect Δro and Δru for the right nostril and for the left. For example, 4 series might run thus :

(1) Δro f. R. N., Δro f. L. N., Δru f. R. N., Δru f. L. N.
(2) Δru f. L. N., Δru f. R. N., Δro f. L. N., Δro f. R. N.
(3) Δru f. R. N., Δru f. L. N., Δro f. R. N., Δro f. L. N.
(4) Δro f. L. N., Δro f. R. N., Δru f. L. N., Δru f. R. N.

With the standard olfactometer, after some practice in cleaning the tube, we took usually 32 determinations in an hour; with the fluid-mantle olfactometer, 24. It was not worth while to take more even if there was time, as the effect of exhaustion became too marked. Fortunately, the odors of the solids used with the small and easily handled olfactometer, were less exhausting than the insistent smells of most of the solutions.

With an unpracticed subject, we used one standard a day. With a practiced subject, we took determinations first with a weaker, then with a stronger standard on the same day. If the substance was very exhausting, we worked first with a weaker, then with a stronger, then with a weaker, then with a

stronger standard. The subject was always warned of a change in the standard.

Two grounds of objection to the method of just noticeable differences are mentioned by Wundt. They are the haphazard choice of the more intensive stimulus, which may light upon a stimulus unnecessarily large, and thus weary the subject's attention and sense-organ unnecessarily, and the irregularity and immeasurability of the moving back and forth in the vicinity of the difference-limen,—the "Tatonnieren." It should be noted, however, that as exhaustion increases during the act of determination, $\triangle ro$ would always be too large and $\triangle ru$ too small, were it not that adhesion has a precisely opposite effect, which is increased by the time-error. Thus, there is really a rude double cancelling of errors.

The true method of minimal changes involves great practical difficulties if applied to difference-determinations with Zwaardemaker's olfactometer. On account of the adhesion in the inhaling-tube, either two olfactometers must be used, and both inhaling-tubes cleaned after every comparison of two stimuli, or only such substances must be used as are insoluble in water and do not condense on the inner surface of the inhaling-tube. Zwaardemaker tried the method with vulcanized India-rubber, and believes it to be practicable for this substance.[1] We, too, tried it with the tube of red vulcanized India-rubber sent from Holland, and obtained very satisfactory results. (See Table VIII.)

We also tried a combination of the two methods mentioned. Giving the subject a variable stimulus objectively equal to the standard, we bade him make it subjectively equal,—for it would tend to seem subjectively less from the effect of exhaustion,—and then after pausing to let us take the reading, to make it subjectively just greater than the standard. Then he was directed to make a variable stimulus very appreciably greater, just equal subjectively. Next, after making an objectively equal stimulus subjectively equal, he made it subjectively less. Lastly, he made an appreciably weaker stimulus subjectively equal to the standard. Some of the results obtained by this method are given in Table VII. They are arranged in connection with results obtained for the same subject, substance and standard by the method of just noticeable differences. The uncertainty of a method in which the subject exhausts an already wearied organ by hunting for subjective equality before proceeding to the determination proper, is obvious. Therefore, the two sets of results tally surprisingly well.

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[1] Pp. 189-190.

With any form of the method of just noticeable differences in which the subject himself alters the stimulus of comparison, there is liability to serious error from the subject's inclination to judge in terms of movement. When he has found that a certain hand-movement has made the stimulus of comparison just noticeably greater or less than the standard, he will expect the same movement to make it just noticeably greater or less again. He will be all the more tempted to judge in terms of hand-movement from the fact that he has been all his life forming estimates of space in terms of the sensations produced by movement, and has probably never thought of taking pains to compare the intensity of two odors. This tendency varies much in different subjects. Its presence may be suspected when the mean variation of a series is very small. Fortunately, it acts in such a way as rather to conceal the operation of Weber's law, if applicable, than to make it appear applicable if it were not. If, for example, one finds $\triangle r$ to be 5 mm. for a standard of 20 mm., and by repeating the series of movements, obtains the same value of $\triangle r$ for a standard of 40 mm., $\dfrac{\triangle r}{r}$ will be ¼ in the one case, and ⅛ in the other.

As a matter of fact our results offer evidence for the law which is strong to an almost suspicious degree. Yet it is not probable that a trained subject would, or that an untrained subject could deliberately alter his movements, when the standwas varied, so as to keep the value of $\dfrac{\triangle r}{r}$ approximately the same, and it is absolutely impossible that twelve subjects out of thirteen should all do so. Such a procedure would argue a miraculous combination of psychophysical knowledge, accurate memory, industry and malice.

We also made some attempt to test the applicability of the method of right and wrong cases. At the time we tried it, which was early in the course of our experiments, we found it utterly impracticable. The fact that more than half the mistakes were made in thinking the second stimulus weaker than the first or equal to it, would indicate that exhaustion was the disturbing factor. Since, however, the subject seems genuinely to recognize the stimulus of comparison in the gradation-methods as greater or less than the standard, it is probable that the difficulty with the method of right and wrong cases is largely the utter confusion it produces in his mind. Most persons are not used to smelling attentively and have to " learn " a given smell-intensity.

Chapter II. Apparatus and Materials.

Section 1. The Standard and Fluid-Mantle Olfactometers.

In our experiments, we employed the single "standard" olfactometer and a double form of the "fluid-mantle" olfactometer. Both instruments were supplied from Utrecht. The sliding tubes used with the standard or small olfactometer were formed of the odorous material itself, and covered with an outer tube of glass. Porcelain cylinders, saturated with odorous solutions, and fitted into larger glass tubes, have been largely used by Zwaardemaker in connection with this simple instrument. We, however, used the porcelain cylinders only with the large or fluid-mantle olfactometer. We shall reserve the consideration of the preparation of the odorous substances to the next section. Here we shall describe the screen and inhaling-tube of the small instrument, and all the appurtenances of the large instrument, except the odorous solutions.

I. *Standard Olfactometer.* The glass inhaling-tube has a total length of 15 cm. and a bore of 5 mm. The glass varies in different tubes from 1 to 1½ mm. in thickness. The portion which curves upward to fit into the nostril is never more than 1½ cm. long. Zwaardemaker says that the angle of the bend seems to make no difference with the results of the experiment. He himself makes it a right angle, but Reuter makes it an angle of 40 degrees.[1] A metal sleeve carrying a raised bead at the edge towards the bent end of the tube and buttoning into a metal ring in the center of the small wooden screen is fastened to the tube in such a position as to allow 10 cm. to project beyond the screen. This portion is graduated into twenty divisions of 5 mm. each. The securing of the metal to the tube is a serious problem in practice. We were able to find neither odorless glue nor cement which would withstand the constant washing of the tube, and the drying over the spirit-flame, a performance which must be repeated from four to a dozen times in a single hour. We finally solved the difficulty for ourselves by pasting with freshly dissolved gum arabic a strip of paper to the tube, and working the metal ring down over it, where it fitted so tightly as not to be removed without a process of soaking. The graduated tubes can be easily duplicated by any glassware firm.[2] They are so frequently broken in cleaning by an unpracticed operator, that no extended course of experiments should be undertaken without laying in a stock of them.

The screen is a square bit of cherry wood,—7½ cm. broad by 10 cm. high by 1 cm. thick,—furnished with a handle and coated with varnish which is supposed to be odorless. The screen must, however, be freely exposed to the air, and when new, must be well sunned, or it will have a decided smell of its own. Its double purpose is to serve as a handle, and to protect the nostril not in use from the odor of the sliding cylinder. The subject in making his determination holds the handle of the screen in his left hand and moves the cylinder with his right.[3]

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[1] P. 104.

[2] Messrs. Eimer and Amend, of New York, courteously duplicated for us all of our imported tubes.

[3] The standard olfactometer can be made in any laboratory. See the

II. Fluid-Mantle Olfactometer. In this instrument, the constant saturation of the hollow porcelain cylinder is secured in the following manner :   A section of wide glass tubing is secured between two circular and cork-lined end-plates of metal.   One of the metal plates,— that which when the instrument is adjusted is nearer to the subject, —is furnished with three equidistant rods, inside of which the disks of cork and the glass tube fit.   The three rods terminate in three screws with detachable heads.   The screws pass through holes in the other metal plate.   The plates are bored at the center to circular openings, 8 mm. in diameter, which coincide with the bore of the enclosed porcelain cylinder.   The cylinder itself, which has exactly the length of the glass tube,—10 cm.,—is held in place simply by the pressure of the end-plates.   The glass inhaling-tube passes through the screen into the bore of the cylinder.   The odorous solution is put into the space between the cylinder and the glass tube with a pipette through one of two holes, 2 mm. in diameter, which are left one in each of the two metal plates, and closed with cork-lined screw-heads.   It would be better if there were two of these holes in each plate, for it is extremely difficult to force a sluggish liquid, such as glycerine, against the pressure of the air into the space around the cylinder.   If the rubber of the pipette is flaccid, it becomes almost impossible.

The "shells" thus constructed for mantling the cylinder with liquid, are mounted in a horizontal position on a wooden table,—27.7 cm. long by 16.4 cm. wide,—which can be adjusted to the required height above a heavily leaded base.   Each of the shells can be moved to and from the observer along a way of hard wood.   The rack and pinion movement is governed by milled heads,—diameter 2½ cm., —projecting from the table to right and left within easy grasp of the subject's hand.   A scale and pointer enable the observer to determine how far the cylinder is moved.

The inhaling-tubes are made with the same bore and of glass of the same thickness as the graduated tubes used with the standard olfactometer.   Those sent from Holland turn, one to the right and the other to the left before curving upward to be inserted in the nose.   The metal sleeves, within which the tubes are cemented, do not bolt into the holes in the screen, but flare off each on its outer side into flat fan-shaped pieces of metal, which are screwed into tally with a mark on the screen.   We made no experiments with these tubes, but used instead tubes of the same bore and thickness of glass, either with a somewhat shorter upright, or with but one curve.   The tubes with one curve are precisely like the inhaling-tubes of the standard olfactometer, except that the part which extends through the screen is longer and is not graduated.   It is a mistake to use two-jointed tubes at all, unless both nostrils are to be used, as in compensation-experiments.   The extra curve seems to make no difference in the results, but it makes the tubes much harder to clean.   The total length of our two-jointed tubes was 18½ cm., and that of our one-jointed tubes, 17½ cm.   11.3 cm. of every tube used must project beyond the screen.   We fitted our tubes into hollow plugs of cherry wood turned to order in the shape of corks, so as to pass easily into the holes of the screen, and

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directions given in Sanford: *Experimental Psychology*, p. 371.   Scripture's blotting-paper olfactometer as, made by Willyoung, is rendered useless by the vulcanized India-rubber of the inhaling-tubes.   We substituted for the inner glass-tube, rubber-tube, and nose-piece, a glass tube bent at right angles and expanded into a nose-piece at its upper end.   The dimensions of this tube, however, make it very breakable, and it is quite impossible to clean it except by blowing through it.

to fit tightly when pushed home. To keep the tubes themselves from slipping backwards and forwards in the plugs, we gummed strips of paper to the glass at the edge of the wood. Lumps of these strips will continue to adhere even after many washings. These home-made substitutes for the heavy metal attachments are very serviceable.

We should advise all who purchase the instrument to strengthen the table with metal cross pieces on its under side. The upward warping, which is inevitable, narrows the ways and throws the inhaling-tube out of alignment with the porcelain cylinder. The result is a stiff movement of the rack and pinion on the one hand, and a perpetual breaking of inhaling-tubes on the other. Moreover, if the warping has gone far, the whole table is liable to split. We have also found it necessary to shave the edges of the wooden blocks which carry the shells, and to reduce the friction caused by two spring-brakes placed alongside of the ways. It would be much better if the carrying blocks were moved with cranks, rather than by the milled heads. The exertion necessary to turn the screw and the chafing of the hand by the milling are distracting to the subject's attention. Moreover, the intervals when the experimenter is turning the head to give the stimulus of comparison are undesirably long. Great care must be used in the selection of any oil which is applied to the instrument. We once used clock oil, and afterwards had extreme trouble in eradicating the odor.

The porcelain cylinders for these olfactometers are made by Hooft and Labouchere in Delft, and composed of pure kaolin. They must be kept continually immersed in water, and this must be removed at least daily to minimize the odor of the clay. They must not be dried before they are introduced into their glass coverings. The ends are perfectly smooth, and are glazed for use with the standard olfactometer. The outer and inner surfaces remain porous. All the cylinders used, whether made of porcelain or of the fragrant material itself, have a length of 10 cm., and a bore of 8 mm., so as to slide easily along the inhaling-tube, and to cover, in case of the standard olfactometer, the graduated portion of the tube lying beyond the screen. The external diameter,—counting the thickness of the protecting shell of glass, when present,—varies from 14 to 16 mm.

Section 2.   Preparation of Odorous Materials.

In Table VI (Chapter III, Section 2) the odorous materials are arranged in their order according to Zwaardemaker's scheme of olfactory qualities. We shall here describe them in groups according to their mode of preparation. We shall consider first the preparation of the tubes of solid odorous matter, and afterwards discuss the solutions used to saturate the porcelain cylinders.

I. Preparation of Odorous Substances Used in Solid Form. The solid odorous materials from which tubes or hollow cylinders were prepared were vulcanized India rubber, black, red, and gray ; cedar, rose-wood and musk-root ; Russian leather, yellow wax, paraffine, glycerine soap, mutton-tallow, cocoa-butter and solid oil of mace, asafœtida, gum benzoin, tolu balsam, and a combination of gutta-percha and gum ammoniac in equal parts by weight. Tubes of red and black India rubber, and of gutta-percha and gum ammoniac came with the standard olfactometer from Utrecht. All the other cylinders, and a second tube of gutta-percha and gum ammoniac, were home-made. It is necessary that all such cylinders should be fitted into glass tubes

of the same length in order that no odor from their outer surfaces may pass around the screen.

India rubber has three great qualifications for use in experiments in smell. (1) It can be smelled for a long time by most subjects without blunting the organ; (2) its odor is not easily obscured by other odors, and (3) adheres comparatively little to the inhaling-tube. Two of our subjects (*C.* and *Sh.*), however, complained more of smarting in the nose when using rubber than when using any other substance. The age and mode of preparation of different sorts of rubber, and the amounts of sulphur in them, make some difference in the quality and slight differences in the intensity of the smell. The intensity, is, on the other hand, virtually the same at all degrees of temperature between 13° and 30° C. The cylinder may be prepared by cutting 10 cm. from a rubber tube with a bore of 8 mm., and working it into a glass tube of the same length. The rubber must be clean and new, and, in particular, must never have come in contact with illuminating gas. Although the odor of the rubber when fresh is not easily disguised by other smells, yet the substance easily loses its own odor and takes that of other substances. An inhaling-tube or the broken fragment of one should, therefore, be left in the cylinder so as to cover its inner surface when not in use. Such tubes must never be allowed to lie about unprotected on the shelves of a wooden cupboard. If not sealed by containing the inhaling-tube, they should be rolled up in clean glazed paper and shut up in a jar by themselves.

Our cedar and rose-wood cylinders were turned to order. A block of wood 2½x2½x4½ ins. will make four of these tubes. Each was held in its place in the outer tube of glass by a small bit of "instant crockery-mender" applied to the wood before putting it in. The fit is so tight that the odor of the paste cannot escape. These cylinders also are very liable to lose part of their odor, and should be carefully protected. Messrs. McKesson and Robbins, of New York, furnished a single piece of musk-root large enough to make two cylinders. One crumbled in the turning, but the other broke evenly around the circumference into two sections, which were pushed so tightly into a glass tube as to stay in place of themselves. The crack was almost invisible, and as it was 6 cm. from one end of the tube, it did not render the cylinder really defective. From the Russian leather,—which was genuine, and not the "Russian leather" of America, which is tanned with birch instead of sandal wood,—a piece 24 mm. wide and 10 cm. long was cut, and was fitted into a tube so as exactly to cover the inner surface. Cylinders may be prepared in the same way from India rubber sheeting.

The other substances were all melted and moulded. The glycerine soap was Pear's, the mutton fat employed was fresh from the butcher's, the cocoa-butter, paraffine (the kind used by histologists), gum benzoin and gum ammoniac were such as can be bought of any retail druggist. We obtained of McKesson and Robbins " solid " oil of mace and the pure juice of asafœtida done up in small tin cans, and also a quantity of gutta-percha in narrow fibrous sticks or slabs, and of tolu balsam entirely freed from impurities. For the outside mould, the permanent glass shell must, of course, be used. The glass tubing was cut beforehand in our case into lengths of 10 cm., and these moulds were corked at one end, so that the tube of odorous matter was never quite so long as its shell. For the inside mould, we used an inhaling-tube, or the long straight part of one which had broken at the curve. The tube may be kept upright by digging a hole for the end of it in the cork. This end should be plugged to prevent the liquid from working up into the tube, through which it is sometimes necessary to pour

warm or cold water. All the odorous substances in this group were melted in a water-bath. We crumbled or shaved them into a small beaker, which we floated by means of a ring of cork in a large beaker of water over a Bunsen burner. We tried to melt the gums in a sand-bath, but succeeded only in charring them. The mass which we obtained by melting the gum ammoniac and gutta-percha together was of lighter color than that sent from Holland, and was not entirely free from the fibres of the gutta-percha. It was spongy and easily moulded by the fingers into any desired shape. The soap, paraffine, cocoa-butter and tallow are readily manipulated. They solidify in a very few moments if the outer tube is immersed in cold water, and the removal of the inner mould presents no difficulty. Tubes of these materials were kept all the summer in a room of which the temperature occasionally rose to 94° F., and sustained no damage by the heat. The tubes of soap, however, sometimes shrivel in a few days independently of the temperature. The longer the paraffine is heated the stronger the odor. Zwaardemaker succeeds in giving it an odor as strong as that of tallow or musk-root. We did not try heating it longer than an hour and a half, and our paraffine tubes gave the weakest of all our scents. Tubes of tallow are easy to make and to keep, and do not exhaust the subject's sense-organ to any appreciable extent, and are therefore especially to be recommended.

The oil of mace has a consistency like that of table-butter. It melts rapidly, and solidifies almost instantly when the outer mould is plunged into ice water, but tends to stick to the inner tube, and to come out with it in perfect shape. To remove the inner tube by itself, we filled it with ice water, and then hastily poured a little hot water over the outer mould. When once made, the mace tubes should be kept in a cool place, and the jar in which they stand should not be set on end. While they are in use, they must be grasped only with the tips of the fingers, and must be cooled every few moments with ice or snow. The juice of asafœtida, when pure, never becomes solid enough to be moulded. We poured small quantities of it, when melted, upon a mass of pulverized carbonate of magnesia, and worked the two materials together with our fingers, as one works flour into a very soft dough. We put lumps of this mixture into an outer mould, heated it in the water bath for a few moments, and then forced the inner tube down through the mass as nearly parallel with the outer mould as possible. After many attempts, we succeeded in making several satisfactory cylinders. Their odor, in spite of the adulteration of the asafœtida, is only too strong.

The gums never become very liquid in melting, and they solidify almost instantly when removed from the heat. We found it difficult to pour the gum benzoin, and impossible to pour the tolu and the mixture of gutta-percha and gum ammoniac, into the space between the inner and outer moulds. We poured this mixture and the tolu into the outer tube when empty, and then forced the inner tube into its place, as in the case of the asafœtida. When the fragrant substance is a gum, this inner tube must be greased. We coated it rather thickly, but evenly, with lanolene, which is as nearly odorless as grease can easily be found, and which evaporates quickly. All these tubes of gum retain their odors well, but the tolu is likely to melt out of shape in a hot room.

Before these cylinders are used, the section of odorless substance exposed at the outer end must be covered. We employed a little ring or cap of glazed paper gummed to the surface. Even with this precaution, the odor of the asafœtida, mace, butter and Russian leather, is quite apparent when the instrument is closed by pushing the odorous tube

as far in as possible. It apparently proceeds from such space as there is between the inside surface and the inhaling-tube. The inhaling-tube, on the other hand, must not fit too closely in the inside of the odorous tube, for if it does, the subject will be able to move it only in irregular jerks, and it will, moreover, scrape off shavings from the inside surface of a cylinder of soft material, such as asafœtida or oil of mace. When it is used with the Russian leather, a bit of paper may be gummed around it to make it fit somewhat more closely. Even this, however, does not keep the smell of the leather from making itself apparent in the space from which one breathes through the tube. We attempted to find "negative stimulus-limina" for the troublesome substances, in the following manner: We used a graduated inhaling-tube 4 cm. longer than the ordinary one, and adjusting the cylinder over the 10 cm. nearest the screen, moved out to find the limen. The device was not successful. The odor still diffused itself through the space from which the air was drawn. All the determinations of difference-limina for these substances involve a constant error, — namely, the addition of an increment, which we have no means of measuring, to every stimulus represented on the tube.

II. *Preparation of Odorous Substances in Solution.* Of the odorous substances used in solution, the caryophylline, citral, vanilline, coumarine and heliotropine were among the "De Laire Specialties," and were, with the ethyl butyrate, tincture of musk, and oil of camphor, the gift of Messrs. Dodge and Olcott, of New York. "The De Laire products," writes a representative of Dodge and Olcott, "are not an embodiment of the simple chemical formulas suggested by their names. They are compounds after secret recipes, and their names denote only the odor or flavor or other quality which it is claimed they reproduce or imitate. De Laire's caryophylline, for example, is not the caryophylline of your chemical formulas, a distinctly isolated aromatic principle, but a preparation, having doubtless as its base one of the clove-oil products, which is intended to supply the perfumer with the bouquet of the clove-pink." We have retained the De Laire spelling of their own specialties. The chemical formulæ of butyric ether, valerianic acid, allyl sulphide, and pyridin are, respectively, C_3 H_5. C_4 H_7 O_2, C_5 H_{10} O_2, $(C_3 H_5)$ S, and C_5 H_5 N. The butyric ether used was a commercial product, but the valerianic acid was obtained at the chemical laboratory of the University, and the allyl sulphide and pyridin, as well as the oil of anise, were had of the Theodore Metcalf Company, of Boston.

Our solvents, mixtures, and concentrations were as follows :

Oil of camphor in liquid paraffine, a mixture,	1:500
Caryophylline in pure glycerine, a true solution,	1:500
Oil of anise in liquid paraffine, a mixture,	1:166⅔
Valerianic acid, in water, a true solution,	1:1500
Ethyl butyrate, " " "	1:1000
Citral, in liquid paraffine, " "	1:500
Vanilline, in pure glycerine, " "	1:125
Coumarine, in liquid paraffine, " "	1:1000
Heliotropine, in liquid paraffine, " "	1:125
Natural Musk, the ordinary alcoholic tincture, in water, a mixture,	1:125
Allyl Sulphide, in liquid paraffine, a true solution,	1:1000
Pyridin, in water, a true solution,	1:500
Laudanum, the ordinary alcoholic tincture, a true solution, unmixed.	

Some of the musk was of course precipitated by the addition of so much water, and floated about in dark brown specks, a state of affairs anything but desirable.

We are aware that all the concentrations are startlingly high. We could not, however, use lower concentrations if we were to fix our standard-stimulus in two places on the scale. With a few exceptions, our stimulus-limina were much higher than those given by Zwaarde-maker as normal. These facts will be noted later in detail. Zwaarde-maker recommended vanilline in glycerine in the concentration of 1:1000 and coumarine and allyl sulphide in paraffine in the same con-centration as especially well fitted for difference-determinations. We did use the coumarine and allyl sulphide in these concentrations, but most of our subjects obtained no odor whatever from the vanilline at 1:1000, and in no case did the stimulus-limen fall for both nostrils below 36 mm.

For coumarine, heliotropine and tincture of musk, stimulus-limina were found in a satisfactory manner. With all the other substances, an odor was apparent when the pointer of the fluid-mantle olfactom-eter stood at zero. The odor, undoubtedly, came from the space between the inhaling-tube and the inside of the porcelain cylinder, as great pains had been taken to wash away every drop of liquid from the metal plates. It is almost impossible so to adjust the inhaling-tube that it will not scrape against the clay at some point, and to paste paper around it would be out of the question, since the paper would continually rub and wipe the odorous surface. The odor was apparent 4 cm. from the end of the ordinary inhaling-tube when the cylinder was supposed to be sealed. All the determinations of differ-ence-limina for these substances also are, therefore, subject to a constant error, but not so great an error as occurs in the results for the troublesome solids with the exception of Russian leather. The odor of the solutions when the instrument was closed was usually barely liminal.

When water was used as a solvent, it was, of course, distilled. The measuring-glasses and the bottles used should be rinsed well with distilled water, or at least with water which has been freshly steril-ized by boiling just before the liquids are poured into them. An aqueous solution becomes unfit for use if long exposed to the light. Zwaardemaker advises that the fluid-mantle of the porcelain cylin-der be changed every two days. We usually not only changed the mantle, but made a fresh solution, as often as this. It is safe to use the same glycerine or paraffine solution for days or even some weeks. The glycerine is much more difficult to put into the receptacle than the paraffine, and for citral and caryophylline it is not so able a solvent. It is difficult, however, to obtain and keep liquid paraffine quite free from a slight odor, somewhat pungent and somewhat like that of vaseline. Alcoholic solutions are, of course, more or less undesirable, as we have noted before. If $\frac{\triangle r}{r}$ were known to be the

same for all qualities, there would be no objection to using such solu-tions, but to assume that it is, is to beg one question at issue. We could not manage the musk and the opium, however, in any other form.

Section 3. Other Arrangements and Appliances.

For cleaning the inhaling-tubes, one needs a funnel of which one end is small enough to fit into the bore ; two small light vessels,— tin cups are best,—for pouring water back and forth through them ; a roll of absorbent cotton ; a piece of pliable brass wire ; some listerine ; and a small alcohol lamp. After a tube is washed, it must be wiped inside and out with absorbent cotton before it is dried more thoroughly over the spirit-flame, else it will break. We used listerine occasion-

ally as a deodorizer during a set of experiments, and always as a disinfectant at the end of the hour. Its own odor is easily washed away. As it takes some time for a porcelain cylinder to become thoroughly impregnated with an odorous solution, it is convenient to have test-tubes with tightly fitting corks, in which a number of cylinders may be put to soak at the same time. Unless they can be kept in a dark cupboard, it is well to wrap up these tubes in several plies of black calico. Bottles of yellow glass, such as perfumers recommend for the safe keeping of heliotropine, might well be used for all the solutions, but if they are not available, the ordinary bottles of colorless glass can be wrapped up in black cotton cloth. The less woolen cloth about the room, the better. We keep our solid cylinders in "self-sealing" preserve jars. When the cylinder with its fluid-mantle in place is not in use, the bore should be corked to keep the inner surface from drying off. It may, indeed, be filled with the solution and corked when it is put away for some time. In this case, all drops of liquid must be wiped out with absorbent cotton before the experiments begin. If it seems likely that much odorous substance has condensed on the inner surface, the whole bit of apparatus, glass shell and all, may be immersed in water. The bore should then be filled for a few hours with the odorous liquid.

The walls of the room in which our experiments were made are covered with oiled paper, and the floor is covered with oil-cloth which has a coating of shellac. The room has at present this defect, that when the wind blows in certain directions, it is impossible to create through it a draft of air which does not pass first through a hall frequented by students and therefore dusty, and by no means free from odor. When the standard olfactometer was used, the subject sat between the observer and the window, and at right angles to the observer, so that the light shone through the graduated inhaling-tube. When the fluid-mantle olfactometer was used, subject and observer sat at right angles to each other at the end of a low table.

Chapter III. Results.

Section 1. The Several Subjects and their Stimulus-Limina.

Individual variations in the sense of smell are so great that it is necessary to preface a chapter on experimental results with an account of the subjects. The following notes upon our subjects in alphabetical order are thrown into "noun-form" for the sake of brevity.

Be. (Dr. I. M. Bentley), a *trained* subject.
Organ impaired by acute catarrhal troubles and easily exhausted.
Breathing spots always blurred and ragged at the division lines,—indicating a catarrhal condition of the membranes,—and never quite symmetrical.
$r\lambda$ usually determined with one *inspiration ;* Δr determined with from 2 to 4 *inspirations.*
Movements of cylinder long and slow, but few.
Position indicative of strain.

Bi. (Miss E. M. Bickham), a wholly *untrained* subject. *General physical condition* neurasthenic.
Organ twice operated on (in '95 and '96) for hypertrophy of the

membranes. Superfluous portions removed from both sides. No catarrh now apparent.

Breathing spots usually well-rounded and symmetrical with neat division lines.

$r\lambda$ and $\triangle r$ determined with but one *inspiration*.

Movements of cylinder rapid with little repetition.
Position indicative of strain.

C. (Miss M. H. Carter), a *partially trained* subject.
Organ very easily exhausted. Membranes subject to sudden congestions of blood and mucus upon nervous fatigue. Adenoid growth as a child. (The growth was not cut away, but disappeared of itself.)
Breathing spots ragged, ill-defined, and almost never symmetrical.
Breathing during an experiment irregular and violent. Tendency to sniff obstinate. $r\lambda$ and $\triangle r$ usually determined with 1 or 2 *inspirations*.

Movements of cylinder rapid with little repetition.
Position indicative of much strain.

D. (Mr. S. J. Druskin), a *partially trained* subject.
Breathing spots perfect, as a rule.
$r\lambda$ and $\triangle r$ usually determined with 1 or 2 *inspirations*.

Movements of cylinder at first rapid and few; after practice, tentative with noticeable repetition.
Position indicative of but slight strain.

K. (Mr. T. Kairiyama), a *trained* subject.
Organ much impaired by hay-fever and other catarrhal trouble.
Breathing spots fairly symmetrical as a rule, but ragged at the edges.
$r\lambda$ and $\triangle r$ usually determined with 1 or 2 *inspirations*. Expiration violent (" to clean out the smell ").
Movements of cylinder tentative but few.
Position indicative of but slight strain.

M. (Miss E. B. Macleod), a wholly *untrained* subject.
Breathing spots seldom quite symmetrical and never well defined. No catarrh before the current winter.
$r\lambda$ and $\triangle r$ usually determined with 1 or 2 *inspirations*.

Movements of cylinder always irregular from want of practice.
Position easy.

N. (Mr. A. C. Nutt), a *partially trained* subject.
Organ : Easily exhausted. Sensitivity somewhat higher on the right side, as a rule. (The subject complained of "feeling left-handed " on the left side.)
Postero-lateral half of left *breathing-spot* usually missing (a fact showing chronic obstruction of the left inferior meatus). Both spots ill-defined.
$r\lambda$ and $\triangle r$ determined usually with 2 or 3 *inspirations*.

Movements of cylinder slow and tentative with but little repetition.
Position indicative of strain.

P. (Mr. C. A. Perry), a *partially trained* subject.
Organ much impaired by chronic catarrh. Diseased portions removed from the lower turbinal bones on both sides.
Breathing spots rarely symmetrical. Secondary division quite apparent in spite of the operation mentioned. Spots ill-defined.
$r\lambda$ and $\triangle r$ usually determined with one *inspiration*.

Movements of cylinder slow and tentative with but little repetition. *Position* indicative of but slight strain.

Rob. (Mr. E. P. Robins), a *trained* subject.
Breathing spots rarely symmetrical or perfectly defined.
$r\lambda$ and $\triangle r$ almost invariably determined with one *inspiration*.
Movements of cylinder slow and tentative with but little repetition.
Position indicative of but little strain.

Rog. (Miss L. R. Rogers), a *partially trained* subject.
Breathing spots rarely symmetrical or very well defined.
$r\lambda$ and $\triangle r$ usually determined with 2 or 3 *inspirations.*
Movements of cylinder slow with much repetition.
Position indicative of but slight strain.

Se. (Mr. W. B. Secor), a *trained* subject.
Organ : Sensitivity somewhat higher on the right side as a rule.
Postero-lateral half of left *breathing spot* usually very small or missing as with N. Spots ill-defined.
$r\lambda$ and $\triangle r$ usually determined with 2 or 3 *inspirations, movements of cylinder* slow with some repetition.
Position indicative of strain.

Sh. (Dr. Stella E. Sharp), a *trained* subject.
General physical condition neurasthenic.
Organ easily exhausted.
Right *breathing spot* usually larger than left, edges of both spots clearly cut.
$r\lambda$ and $\triangle r$ usually determined with one *inspiration, movements of cylinder* slow with little repetition.
Position indicative of much strain.

T. (Dr. Ellen B. Talbot), a trained subject.
Organ somewhat easily exhausted. Portions of both lower turbinal bones removed to prevent congestions of mucous in the upper passages. Sensitivity somewhat higher on the left side.
Breathing spots well rounded and clearly cut. Secondary divisions imperfect. (When the nasal passages were clear the division was represented only by indentations at the edges of the spots.)
$r\lambda$ at first determined with one *inspiration* ; later in the work, with 2, 3, or even 4 as a more satisfactory procedure. $\triangle r$ usually determined with 2 or 3 inspirations.
Movements of cylinder very slow and cautious with much repetition.
Position indicative of but little strain.

In the notes just given a subject is called "trained" if he had had a fair amount of experience in general introspection. Only *Be.* had had any training in smell-experiments before the beginning of the course described in this paper. Some months earlier we had made a futile attempt to find his difference-limen with the weaker Utrecht cylinder of gutta-percha and gum ammoniac by the method of minimal changes. A subject is called " partially trained " if he began psychological laboratory-work about the time when these experiments commenced. The word "repetition" is used in connection with the manipulation of the cylinder to denote the moving backwards and forwards at the limen.
The breathing spots of all the subjects varied much from day to day. Sometimes they were broken up into several bands, always running rather from front to back than laterally. Often one narrow

medial strip would separate from one or the other. In most cases a
more or less jagged and blurred outline showed the adhesion of
clots of mucous to the passage-walls. In fact, twelve out of the thir-
teen subjects had suffered or were suffering from frequent "colds"
or from hypersecretion more or less chronic. As a function of the
turbinal bone is to deflect a part of the inspired air to the upper
passages, its removal damages the sense of smell. The sensitivity of
T.was higher on the left side of the nose, from which, as she reported,.
the smaller amount of bone had been taken, but the small remains of
the secondary division of the breathing spots did not indicate that
more bone had been removed on the one side than on the other. The
obstruction of the inferior meatus would not, in itself, do much mis-
chief to the sense, but it must indicate a dropping of mucous from the
upper passages. It is of some interest to note that the subject (D.)
whose spots are most perfect is a Russian. He came, however, to live
in New York city at the age of twelve. K. is Japanese, but has been
long enough in this country to suffer severely from the catarrhal cli-
mate. Rob., one of the best subjects, comes from Prince Edward's
Island. The homes of the other ten are scattered over the States from
Eastern Massachusetts to California, though none are farther south
than Missouri.[1]

When it is said that $\triangle r$ was determined with one,two,or more inspi-
rations, it is meant that the stimulus of comparison was manipulated
during one, two, or more inspirations. More than one inspiration was
almost never taken to "learn" the standard. It seemed better to risk
the increase of adhesion by allowing a subject to take as many breaths
to a determination as he wished than to make him try to form a judg-
ment when the force of an inhalation was decidedly on the wane.
Many of the subjects considered a judgment with one inspiration an
impracticable ideal. $D.$, $K.$, $Se.$ and $Sh.$, and in a smaller measure
$Be.$ and $P.$, had a bad habit of suspending an inspiration, and not of
sniffing, but of "holding the breath" momentarily during an inspira-
tion. This practice must have tended to weaken the stimulus by
allowing the air in the upper chamber to rush downwards to the mid-
dle meatus. $Be.$, $N.$, $P.$, $Rob.$, $Se.$ and $T.$ noticed that the stimulus
was stronger during the latter part of an inspiration. This may point
to cumulative stimulation of the rod-cells, or it may merely mean an
access of attention and an unconscious sniff. $Se.$, who had the habit
of suspending an inhalation, noticed the increase most after a strong
inspiration, and $D.$, $K.$ and $Sh.$, who had the same habit did not
notice it at all. And it is clear that this peculiar mode of breathing
would tend to prevent cumulative stimulation. On the other hand,
$Be.$, $P.$ and $T.$ noticed the increase most when the stimulus was near
its limen, and this looks as if it were a matter of attention and breath-
ing-rate, especially as $T.$ did not hold her breath. $Be.$ remarked that
the least difference of attention altered the stimulus. $Rob.$ thought
the first part of an inspiration gave the fairest measure of an inten-
sity, and $Be.$ and $Se.$ relied on it "in easy judgments," but judged by
the latter part of the inspiration if the stimulus were weak or vague.
$N.$ and $P.$ asserted that they judged "by the impression as a whole,"
but $N.$ confessed to a tendency "to emphasize the last whiff." $T.$ re-
versed the procedure of $Be.$ and $P.$, usually judging by "the last
whiff," but repeating the inspiration and relying on the first impres-
sion if the determination were difficult. With $Rog.$ exhaustion often
supervened in a long inspiration. If is clear that if the intensity of

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[1] Spraying the subject's nose at the beginning of the hour might be
a useful expedient, but we did not try it.

a stimulus alters with the duration of an inspiration as well as with the manipulation of the instrument, the subject must make more than one inspiration to determine a limen, unless the judgment is very easy. It is probable that the first part of the inspiration, before the smell "blossoms out," gives the best criterion of the intensity of a stimulus. We would suggest that cumulative stimulation of smell would be a profitable subject of investigation.

In an effort to smell with the standard olfactometer, *C.*, *D.*, *K.*, *P.*, *Rob.*, *Rog.*, *Sh.* and *T.* all tipped the head to the left if using the left nostril, and to the right if using the right, pointed the outward end of the inhaling-tube in the same direction as the head was tipped, and slanted the screen in the opposite direction. This odd uniformity is perhaps explicable. On entering the nose the air ordinarily streams a little toward the septum and the opposite directions in which the subject slanted his head and the screen tended on each side to throw the opening of the nose-piece into an acute angle with the septum, while the turn given to the instrument in the horizontal plane threw the opening a little toward the front of the nose. On the other hand, *Se.* exactly reversed these directions on each side, and so did *Be.*, except that he turned the tube to point in the same direction as the screen was slanted, so throwing its inner opening towards the back of the nose. *Bi.* slanted both head and screen to the right when using the right nostril, and to the left when using the left. This was probably a mere matter of attention to one nostril or the other. She was not consistent in the pointing of the tube. *N.* turned everything to the right. Unfortunately, no written notes were taken of the hand used, but it was usually the right, the hand farther from the experimenter. All the subjects tended to tilt the hand forward and the screen backward,—probably in their desire to get "nearer" the stimulus. Almost all, unbidden, closed their eyes.

T. once mentioned verbal associations as an aid in memorizing the stimulus. This expedient was not common. *Be.* wrinkled his forehead and nose in a marked degree, and once noted a tendency to judge in terms of strain, especially about the eyes. Some substances were pungent to a disturbing extent to every one, but *C.* and *D.* complained much of "pain" from odors which no one else thought pungent. *D.* explicitly distinguished the sensation from pressure. He thought coumarine both pungent and "sour." Both *C.* and *D.* said that they received simply sensations of pressure from some stimuli. With *D.* sensations of smell merged in sensations of pressure as the organ became exhausted. *C.* said that when she tried to smell the black rubber with the left nostril she merely felt as if she were "breathing a feather," or as if the inside of her nose were "pressed with a soft wad." Yet the judgments made with this nostril agreed pretty well with those made with the other. *Be.* occasionally spoke of sensations of pressure or pain from the stimuli. Most of the subjects expressly denied temperature-associations. *Be.*, however, said that tolu and heliotropine were cold; *M.* that cocoa-butter was cold; *Rob.* that vanilline was cold; and *N.* that white tallow and musk-root were warm, and camphor cold, and that every smell grew warmer as it grew stronger. He thought of heliotrope as "warm, dark and deep," in contrast with ylang ylang, which was "light and fluffy."

The comparative sensitivity of the subjects may be judged from the following Table:

TABLE I. A TABLE OF STIMULUS–LIMINA.

Part I. Stimulus–Limina Arranged to Show Individual Variations.

SUBSTANCE.	Nostril.	Be	Bi.	C.	D.	K.	M.	N.	P.	Rob.	Rog.	Se.	Sh.	T.	Z.
		M	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.
Black rubber,	R.	36		4	(22)	(43)	(35)	12		(61)	I	(12)	7	(38)	
	L.	34		5	(23)	(59)		11		(50)	I	(23)	10	(30)	
Gray rubber,	R.	9	(35)		I		(19)				(I)	5	(7)		
	L.	8	(29)		6		(22)				(I)	9	(10)		
Red rubber,	R.									(I)		(4)			7
	L.									(0)		(5)			
Russian leather,	R.	0				0							0		10
	L.	0				0							0		
Paraffine,	R.									12		(21)			10
	L.									20		(14)			
Rosewood,	R.					6		8	(54)		3				3
	L.					8		7	(67)		11				
Cedar,	R.		(4)					(27)		(10)		5	31	20	
	L.		(5)					(29)		(12)		10	13		
Gum benzoin,	R.		7	7				(19)				(6)		10	
	L.		8	7				(17)				(8)			
Gum ammoniac & gutta-percha: (1) First	(1) R.				(7)				(9)	(8)	(12)				
	(1) L.				(17)				(8)	(10)	(21)				
Utrecht cylinder, (2) Second	(2) R.								(9)						
Utrecht cylinder, (3) Home-made cylinder,	(2) L.								(8)						
	(3) R.							9	2						
	(3) L.							18	4						
Yellow wax,	R.														2.5
	L.														
Cocoa-butter,	R.	10	(16)			(7)		7							1
	L.	8	(17)			(4)		12							
Tolu balsam,	R.	14			4	I	(62)				I		9	1	
	L.	19			3	I	(49)				6		5		
Musk-root,	R.							4				7			
	L.							8				5			
Mutton-tallow,	R.							4				2			
	L.							6				5			
Asafœtida,	R.	0				0							0		
	L.	0				0							0		
Oil of Mace.	R.			0	0	0		0	0	0		0			
	L.			0	0	0		0	0	0		0			
Coumarine,	R.	17	(2)	(20)	(6)	(8)	(1)		(25)	(12)	(12)	(4)	(27)	(36)	
	L.	23	(2)		(6)	(12)	(3)		(21)	(11)	(10)	(5)	(54)	(33)	
Glycerine soap,	R.					(19)			(12)	(7)					2
	L.					(15)			(13)	(4)					
Heliotropine,	R.	24						(33)						(9)	
	L.	39						(33)						(10)	
Musk.	R.					(8)						(7)			
	L.					(2)						(7)			

TABLE I.—*Continued*.

Part 2. Stimulus-Limina Arranged to Show Variations Due to Practice and to Differences of Temperature.

SUBJECT.	SUBSTANCE.	NOSTRIL.	Value of $r\lambda$ in cm.	THERMOMETER READING.
Be.	Tolu balsam	R.	(32)	53°F
		L.	(35)	
		R.	14	60
		L.	19	
K.		R.	(24)	54
		L.	(28)	
		R.	(21)	52
		L.	(22)	
		R.	4	64
		L.	3	
	Rosewood	R.	(16)	59
		L.	(29)	
		R.	(13)	64
		L.	(22)	
		R.	6	62
		L.	8	
P.	Cocoa butter	R.	(27)	62
		L.	(26)	
		R.	(19)	62
		L.	(27)	
		R.	7	66
		L.	12	

All the values of $r\lambda$ given in this Table are averages of several determinations taken on the same day. Those enclosed in parentheses were found when the subjects had had little or no experience with the substances in question. Those not so enclosed were found after the respective substances had been used by the several subjects in difference determinations. In the first part of the Table, the limen given is in every case the last limen found for the subject and substance, and all the last limina found are given. The second part of the Table simply contains results selected by way of illustration, but all the limina found for the subject with the substance in question are included.

In Part 1, all the substances but the last four are taken in order from a Table in which Zwaardemaker arranges various materials for solid odorous cylinders in the order of their intensity.[1] The limina in the column headed Z are those given by him in another Table as normal at a temperature of 15° C., or 59° F.[2] The temperatures at which our records were taken lay for the most part between 60° and 70° F. Our limina ought, therefore, to be lower than his, instead of higher. We cannot satisfactorily explain the difference between our results and his in the matter of stimulus-limina. That the limina of Americans should be higher than those of Dutchmen is not indeed surprising, but the entire change in the rank of the substances is. According to Dr. Reuter. as cited by Zwaardemaker, the gum ammoniac and gutta-percha cylinder is forty times as strong as the vulcan-

[1] *Op. cit.*, p. 118.
[2] P. 167.

ized rubber, and the musk-root is five times stronger than the former. The tallow, Zwaardemaker says, is stronger still. We regret that we could not find stimulus-limina oftener. The washing of the tube consumed so much time that this was impossible. We feel that the results embodied in Table I are the most unsatisfactory part of our work. Yet if allowances be made for exhaustion in some of the results of *C.* and *Sh.*, and for expectation gradually controlled by practice in the cases of *Bi.*, *M.* and *Rog.*, the Table will serve its purpose.[1]

We have not space to give our temperature records in full. They varied so irregularly that the arithmetical mean by no means represents the most common reading. As the steam had to be kept shut off when we were not in the laboratory, the exact regulation of the temperature involved serious practical difficulties, and for most of our work it was a matter of minor importance, for in difference-determinations variations of temperature and moisture affect the standard-stimulus and the stimulus of comparison equally, and may, therefore, be disregarded. Indeed, our barometer-records, though carefully kept, proved to be wholly a work of supererogation, for in the case of the very few substances (glycerine soap, coumarine, heliotropine, vanilline, and allyl sulphide) which were somewhat soluble in water and yet not in aqueous solution, we did not succeed in finding stimulus-limina on different days.[2] Practice lowered the stimulus-limina in a conspicuous manner, but the effect of variations in temperature can only occasionally be traced in the complete results. Part 2 of Table I illustrates this fact with fairness.

It only remains to say that *Be.*, *C.*, *K.*, *N.*, *Se.* and *T.* worked twice a week for at least part of the year and the others once.

Section 2.   *Results Obtained by the Method of Just Noticeable Differences.*

Since in the nature of the case numerical proof of the applicability of Weber's law to a given sense department cannot be thrown into the form of averages, and since we have not space for the great mass of figures which we have at hand, we must offer first samples and then summaries of our evidence, and content ourselves with them. Tables II and III are the samples, and Tables IV, V and VI are summaries from different points of view. TableI V constitutes the most decisive proof of the validity of the law. Tables V and VI are intended to confirm the conclusion to be drawn from Table IV, and to show the probable value of $\frac{\triangle r}{r}$. In Tables III, IV, V and VI, *every value given or enumerated is an average* of the results of one day's work with one subject, nostril, substance and standard. All the work done with this method, however unsatisfactory, is represented in Tables V and VI.

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[1] The writer's own limina are lower than those of any of the subjects. Abnormal keenness of smell has persisted from childhood, in spite of the usual share of "colds."

[2] For the effect of atmospheric moisture in Zwaardemaker's method, see Chapter I, Section 2.

TABLE II. CONSECUTIVE RESULTS OF ONE SUBJECT, *T.*

DATE.	SUBSTANCE.	Nostril.	No. of values averaged.	r	△ro	△ru	△r	△r/r	Disturbing factors.
Nov. 9,	Tolu balsam	R.	6	20	4(2)	7(3)	5½	4	
		L.			5(2)	5(1)	5	4	
13,		R.	6	30	2(1)	14(2)	8	4	
		L.			3(2)	9(5)	6	5	
16,		R.	3,4	20	1(1)	6(4)	3½	6 [Z]	
		L.	3,3		4(2)	4(2)	4	5 [Z]	
		R.	4	30	6(3)	8(2)	7	4	
		L.			4(2)	7(4)	5½	5	
19,		R.	4,3	20	4(1)	1(2)	2½	Z [Z]	
		L.	3,3		5(3)	6(4)	5½	4 [Z]	
		R.	4	30	6(2)	7(3)	6½	5	
		L.			4(4)	5(3)	4½	Z	
30.	Russian leather,	R.	4,2	24	7(2)	3(1)	5	5 [Z]	
		L.			6(1)	5(2)	5½	4	
		R.	4	44	8(2)	9(2)	8½	5	
		L.			10(3)	12(3)	11	4	
Dec. 10,		R.	4	24	3(2)	6(2)	4½	5	
		L.			6(4)	7(2)	6½	4	
		R.	4	44	6(4)	10(3)	8	6	
		L.			8(3)	11(4)	9½	5	
14,	Asafœtida,	R.	3	8	5(4)	4(1)	4½	A	
		L.			6(0)	7(1)	6½	A	
		R.	3	13	4(3)	10(2)	7	A	
		L.	2,3		5(1)	8(1)	6½	2 [2]	
	Russian leather,	R.	2	9	5(3)	—	—	- [Z]	Exhaustion.
		L.	3,1		4(2)	0(-)	2	5 [6]	
16,	Asafœtida,	R.	2,1	8	3(3)	6(-)	4½	A [Z]	(General fatigue.
		L.	3,1		4(1)	3(-)	3½	2 [5]	(Exhaustion.)
		R.	3	13	3(2)	6(2)	4½	3	
		L.	2,3		8(1)	5(2)	6½	2 [3]	
	Russian leather,	R.	3,2	9	6(4)	1(1)	3½	3 [3]	
		L.	3,1		5(1)	3(-)	4	2 [6]	
20.	. safœtida,	R.	1,3	8	3(-)	3(2)	3	3 [Z]	Exhaustion.
		L.	1,1		3(-)	0(-)	1½	5 [-]	
		R.	3,2	13	6(1)	6(1)	6	2 [3]	
		L.	3,2		7(1)	3(2)	5	3 [3]	
	Russian leather,	R.	1,2	9	10(-)	1(2)	5½	A [6]	Exhaustion.
		L.	3,1		3(1)	1(-)	2	5 [Z]	
Jan. 8,	Cedar,	L.	4	22	8(2)	8(3)	8	3	Exhaustion.
11,		R.	4,2	22	8(2)	6(2)	7	3 [5]	(Exhaustion.)
		L.	3,4		6(3)	8(3)	7	3 [4]	(Pungency.)
		L.		42	11(1)	10(1)	10½	4	
22.	Asafœtida,	R.	2	12	8(4)	8(0)	8	A	General fatigue.
		L.			5(3)	8(1)	6½	A	
		R.	2	22	14(2)	13(2)	13½	A	
		L.			8(1)	14(0)	11	2	
Feb. 1,		R.	3	22	8(2)	8(1)	8	3	
		L.			8(3)	8(3)	8	3	
		R.	3	12	10(1)	8(1)	9	A	
		L.			9(2)	7(1)	8	A	
5,	Coumarine,	R.	3	56	14(2)	7(4)	10½	5	
12,	Heliotropine,	R.	4	28	15(2)	11(0)	13	2	

TABLE II.—*Continued.*

DATE.	SUBSTANCE.	Nostril.	No. of values averaged.	r	$\triangle ro$	$\triangle ru$	$\triangle r$	$\dfrac{\triangle r}{r}$	Disturbing factors.
Feb. 12,	Heliotropine,	L.			13(1)	11(2)	12	2	
		R.	3	48	18(0)	17(1)	17½	3	
		L.			20(2)	15(1)	17½	3	
18,		R.	2	28	17(0)	13(0)	15	A	
		L.			14(2)	11(0)	12½	2	
		R.	2	48	18(1)	15(0)	16½	3	
		L.			19(5)	14(0)	16½	3	
26.		R.	2	27	13(0)	10(0)	11½	2	
		L.			12(1)	8(1)	10	3	
		R.	2	47	19(1)	14(3)	16½	3	
		L.	1,2		16(-)	9(2)	12½	4	
Mar. 1,		R.	3	27	13(1)	8(0)	10½	3	General fatigue.
		L.			12(2)	8(0)	10	3	
		R.	3	47	18(1)	15(0)	16½	3	
		L.			18(0)	15(1)	16½	3	
3,	Valerianic acid,	R.	3	18	15(2)	9(1)	12	A	{ Pungency.
		L.			14(2)	7(3)	10½	A	{ Exhaustion.
		R.	2	38	18(1)	13(1)	15½	3	
		L.	2,3		16(2)	9(2)	12½	3	
8,		R.	2	18	13(1)	3(2)	8	2	
		L.	3		12(1)	4(2)	8	2	
		R.	2	38	16(2)	6(4)	11	4	
		L.	1,2		18(-)	5(0)	11½	3	
18,		R.	2,1	18	15(2)	4(-)	9½	A	{ General fatigue. Nose-bleed during the day.
		L.	2		15(3)	3(2)	9	2	
		R.	2,1	38	24(2)	11(-)	17½	2	
		L.	2		20(1)	11(0)	15½	3	
19,		R.	2,3	18	11(1)	5(1)	8	2	{ Irritation of nasal membranes. Exhaustion.
		L.	2		12(0)	—	—	—	
		R.	3,2	38	16(1)	10(4)	13	3	
		L.	2		17(1)	10(3)	13½	3	
21,		R.	3	18	13(1)	7(2)	10	A	{ Irritation of nasal membranes.
		L.	3,2		13(0)	7(1)	10	A	{ Smell of tobacco.
		R.	3	38	16(1)	13(1)	14½	3	
		L.	2		18(1)	11(2)	14½	3	
26.	Citral,	R.	2	13	8(1)	5(2)	6½	2	{ Irritation of nasal membranes.
		L.	3,2		8(1)	4(2)	6	2	
		R.	2,1	28	13(0)	8(-)	10½	3	{ Homatropin freshly put into the eyes.
		L.	3,2		12(2)	7(1)	9½	3	
Apr. 16,		R.	1,2	13	7(-)	0(0)	3½	4	
		L.	2		8(1)	2(1)	5	3	
		R.	3	28	12(0)	4(2)	8	4	
		L.	2,3		12(1)	5(2)	8½	3	

T. whose results seem best fitted to be used as an illustration, worked twice a week, as a rule, during the time covered by this Table. No difference-determinations obtained from her during this time by the method of just noticeable differences have been omitted. In October, we worked with her once a week, but were occupied chiefly in finding stimulus-limina. She also worked for us several hours late in the spring with results which did not differ materially from those embodied in the table. The fourth column of the Table gives the number of values averaged to obtain the figures given in the columns headed

$\triangle ro$ and $\triangle ru$. If two figures stand on a line in the fourth column, the first refers to $\triangle ro$ and the second to $\triangle ru$. One figurerefers not to both together but to each alike. The numbers in parentheses are all mean variations. A dash in parentheses means that the number by which it stands is not an average. In the column headed $\dfrac{\triangle r}{r}$, for the sake

of brevity values greater than $\frac{1}{2}$ are indicated by the letter A; values equal to $\frac{1}{2}$ or less, but nearer to $\frac{1}{2}$ than to $\frac{1}{3}$, are indicated by the figure 2; values equal to $\frac{1}{3}$ or nearer to $\frac{1}{3}$ than to $\frac{1}{2}$ or to $\frac{1}{4}$, by the figure 3; values equal to $\frac{1}{4}$ or nearer to $\frac{1}{4}$ than to $\frac{1}{3}$ or to $\frac{1}{5}$, by the figure 4; values equal to $\frac{1}{5}$ or nearer to $\frac{1}{5}$ than to $\frac{1}{4}$ or to $\frac{1}{6}$, by the figure 5; values equal to $\frac{1}{6}$ or greater, but nearer to $\frac{1}{6}$ than to $\frac{1}{5}$, by the figure 6; and values less than $\frac{1}{6}$, by the letter Z. Every subject sometimes moved the cylinder beyond the standard, and the reading, if taken at all, could be written only as a minus quantity. This crossing of the standard almost never occurred with the fluid-mantle olfactometer, and when it did the error was so easily explained that the reading was not taken. Between November 9 and the time when the liquids were first used, two sets of averages were obtained, the first by excluding and the second by including these negative quantities when they occurred. In Tables IV, V and VI, only values representing no negative quantities and differing from averages of the same series with the addition of such quantities by less than $\frac{1}{4}$ are included in the enumeration. The averages enclosed in square brackets in Table II were found by including minus quantities in the average values of $\triangle ro$ and $\triangle ru$. From all unbracketed averages, negative quantities are excluded. A dash in square brackets indicates that the corresponding value of $\triangle r$ is itself a negative quantity.

The effect of some of the disturbing factors which are constant can best be illustrated in connection with this Table. Besides exhaustion, adhesion, and the tendency to júdge in terms of hand-movement, which we call for short "the movement-error," some obstruction of the nasal passages, some slight compensating-smells, such as that of the absorbent cotton used to wipe the inhaling-tube, and some distraction of the attention in manipulating the large instrument, must be taken for granted with all the subjects. Only marked exhaustion is expressly noted in Table II. Another source of error which comes into operation with asafœtida, oil of mace, Russian leather, and all the liquids except coumarine, heliotropine and musk is the escape of odor between the cylinder and the tube. The effect of this circumstance, which was mentioned in Section 2 of Chapter 2, must be to make the value of $\dfrac{\triangle r}{r}$ too large, because it makes the standard larger

than the instrument indicates. If, for example, r on the instrument is 20 mm., but really is 25 mm., and $\triangle r$ is found to be 5 mm., then $\dfrac{\triangle r}{r}$ will be nominally $\frac{1}{4}$ while really it is $\frac{1}{5}$.

As we explained in discussing the disadvantages of the method of just noticeable differences, the effect of the movement-error is to make the value of $\dfrac{\triangle r}{r}$ smaller for the larger

standards, and thus to conceal the operation of Weber's law. If we look now at the values of $\dfrac{\triangle r}{r}$ in Table II, we shall see at a glance that this variation exists. It should be noted that no variation in the order of the standards will eliminate the movement-error. If the smaller standard is given first and a certain habit of movement acquired, this habit will make $\dfrac{\triangle r}{r}$ for the larger standard too small. If the habit is acquired in connection with the larger standard, it will make $\dfrac{\triangle r}{r}$ for the smaller too large. It is true that if the standards were alternated by single determinations, rather than by short series, a habit of movement would be less likely to establish itself, but such a procedure is excessively confusing to the subject in the case of smell, and, moreover, all work done with the smaller standard after the organ is blunted with the larger is more or less unsatisfactory. If the distance between the standards and the stimuli offered as decidedly greater or less were kept not absolutely but relatively equal, the movement-error would be concealed. The fact that these distances cannot be kept absolutely equal, if the stimulus of comparison is to be accepted as such by the subject, is in itself no small confirmation of Weber's law. As a matter of fact, they were kept as nearly equal as possible, both to avoid concealing the movement-error and to minimize exhaustion by strong stimuli. They often varied in the same series as the subject's organ became blunted to all differences and then recovered itself, but in general for a standard of 10 or 15 mm., the difference was made 10 mm. ; for a standard of 20 or 30, 15 ; for a standard of 40 or 50, 20, and for a standard of 60 or 70, 25.

The moving back and forth at the limen is some safeguard against the error, yet the tendency of $\dfrac{\triangle r}{r}$ to be smaller for the larger standards is apparent in the results of subjects whose attention was good and whose movements were careful. Thus, it is particularly well-marked in the work of *Se.*, who was certainly not inferior to any of our subjects. Moreover, the same tendency showed itself when the different standards were used on different days, and a habit in such nice adjustments could scarcely persist from day to day or week to week with so little practice. If (1) the movement-error is one explanation of the variation, (2) the escape of odorous vapor is in some cases another. The equal though unmeasured increment is a larger fraction of the smaller standard than of the larger. If our standards are 20 and 40 and the increment is 4, while

$\dfrac{\triangle r}{r} = \tfrac{1}{4}$ in both cases, then $\triangle r$ will be 6 in one case and 11

in the other, and we must write the values of $\dfrac{\triangle r}{r}\,\tfrac{24}{80}$ and $\tfrac{22}{80}$.

We believe that (3) a fortuitous circumstance in connection with the standard olfactometer is another factor in the same result.   Usually, the last movement made by the subject is an outward movement.   He moves from a point decidedly different from the standard to subjective equality, and then a little way back again,—in and out once or oftener.   In moving the cylinder the hand is apt to slip, and the accidental increment to $\triangle r$ is a larger fraction of the smaller standard than of the larger. Adhesion is not a factor in the case, for it is larger for the larger standard, varies with the length of the determination, has an opposite effect upon $\triangle ro$ and $\triangle ru$, and is balanced in an indefinite way by exhaustion.

It should be noted in Table II that at first $\triangle ru$ is usually slightly larger than $\triangle ro$, but that with practice this variation is reversed. The natural effect of exhaustion is to make $\triangle ro$ larger than $\triangle ru$, for exhaustion does not affect the standard stimulus and stimulus of comparison equally, but progresses all the time that the latter is manipulated.   This tendency is in a manner checked by the time-error and by adhesion. (See Chapter I, Section 4.) Now *Be.*, the one subject who had had some experience in smell-experiments before the beginning of this course, tended from the first to make $\triangle ro$ greater than $\triangle ru$. All the other subjects at first made $\triangle ru$ greater than $\triangle ro$, but all except *Rog.*, *Se.* and *Sh.* changed the tendency with practice or began to do so.   *Rob.*, *N.* and *T.* altered it very soon and decidedly. With *Se.* the values were usually almost equal.   This alteration with practice seems to show that exhaustion causes more disturbance than adhesion and the time-error put together.   This is what we should expect, for although the subject rested while the tube was being cleaned, yet the removal of adhesion was absolute,while the recuperation of the organ was less complete each time.[1] We never can be quite sure, however, whether exhaustion is really decreasing the strength of stimuli regularly, or is blunting all differences or making all movements haphazard.   When a subject complained that his nose felt "hot," "dry," "rough," "scrapy," "sore," or "numb," his movements were often erratic, and the smaller stimulus sometimes seemed as strong as the larger, which probably stunned the already weary organ instantly. The dryness, no doubt, was due to the vigorous breathing.   The tongue of a fever-patient will become much more parched and black if respiration through the nose is obstructed.

The original tendency to make $\triangle ro$ decidedly smaller than $\triangle ru$, and the difficulty of finding the lower stimulus-limen are probably due to the same cause.   Both cumulative stimulation and memory after-images might produce the tendency, though both would be counteracted in a measure by the moving to and fro at the limen.   Against both, the subject would learn to guard in a measure. *Be.* mentioned "after-images" of cocoa-butter, and *Se.* of tolu balsam.   Frequently a subject would complain that he could not "get the strong smell out of his nose."

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[1] Zwaardemaker: *op. cit.*, pp. 203-204.

In the mean variations, as a whole, it is impossible to trace any tendency to be larger in judgments made with reference to the larger standard. Though the larger standard was usually given last, the effect of exhaustion in producing erratic judgments towards the end of the hour seems to have been balanced by a certain lack of practice. At the beginning of the hour, there is a sort of conscious awkwardness, characteristic of these smell-judgments when first attempted. It is impossible to draw from our figures any conclusion in regard to the delicacy of quantitative sensible discrimination in smell. The variations were evidently controlled to a great extent by the peculiarities of the instrument and the subject's habit of movement, and it must be confessed that from day to day the effect of practice upon them was not very clearly marked. All the subjects had smaller mean variations when using the fluid-mantle olfactometer, but this fact can hardly have been due to practice, for, although the other instrument was used first in every case, *Rob.*, *Rog.* and *T.* returned to it after using the large instrument for a while, and showed the same mean variations as they did at the beginning. Moreover, the difficulty of turning the screw-head of the large instrument and

TABLE III.

Complete Results for One Solid and One Liquid Substance.

SUBSTANCE.	SUBJECT.	VALUES OF $\dfrac{\Delta r}{r}$
Gray rubber,	Be.	$\frac{17}{36}$, $\frac{17}{36}$, $\frac{22}{74}$, $\frac{19}{74}$, $\frac{14}{36}$ w. $\frac{17}{74}$ and $\frac{35}{112}$, $\frac{7}{36}$ w. $\frac{21}{74}$ and $\frac{29}{112}$
	D.	$\frac{8}{38}$ w. $\frac{22}{76}$, $\frac{13}{38}$ w. $\frac{19}{78}$
	Se.	$\frac{14}{54}$ w. $\frac{18}{92}$, $\frac{15}{54}$ w. $\frac{19}{92}$, $\frac{15}{54}$ w. $\frac{13}{92}$, $\frac{14}{54}$ w. $\frac{20}{92}$
Coumarine,	Be.	$\frac{16}{52}$, $\frac{14}{52}$
	Bi.	$\frac{12}{32}$ w. $\frac{17}{72}$, $\frac{12}{32}$ w. $\frac{17}{72}$, $\frac{16}{32}$ w. $\frac{24}{72}$, $\frac{12}{32}$ w. $\frac{23}{72}$
	C.	$\frac{24}{92}$, $\frac{17}{52}$, $\frac{25}{92}$, $\frac{23}{52}$ w. $\frac{35}{92}$, $\frac{25}{52}$, $\frac{23}{52}$ w. $\frac{29}{92}$, $\frac{19}{52}$ w. $\frac{27}{92}$, $\frac{17}{52}$ w. $\frac{27}{92}$
	D.	$\frac{14}{32}$ w. $\frac{18}{72}$, $\frac{15}{32}$ w. $\frac{19}{72}$
	K.	$\frac{30}{72}$ w. $\frac{16}{112}$, $\frac{20}{72}$ w. $\frac{27}{112}$, $\frac{18}{72}$ w. $\frac{29}{112}$
	M.	$\frac{24}{52}$, $\frac{28}{52}$, $\frac{30}{52}$ w. $\frac{23}{92}$, $\frac{17}{52}$ w. $\frac{25}{92}$, $\frac{16}{52}$ w. $\frac{28}{92}$
	N.	$\frac{15}{112}$, $\frac{12}{112}$, $\frac{26}{72}$ w. $\frac{27}{112}$, $\frac{20}{72}$ w. $\frac{26}{112}$, $\frac{18}{72}$ w. $\frac{26}{112}$, $\frac{18}{72}$ w. $\frac{24}{112}$
	P.	$\frac{24}{72}$ w. $\frac{26}{112}$, $\frac{21}{72}$ w. $\frac{26}{112}$
	Rob.	$\frac{25}{72}$ w. $\frac{33}{132}$, $\frac{27}{72}$ w. $\frac{33}{132}$, $\frac{19}{72}$ w. $\frac{21}{32}$, $\frac{16}{72}$ w. $\frac{18}{32}$, $\frac{14}{32}$ w. $\frac{25}{72}$, $\frac{13}{32}$ w. $\frac{25}{72}$
	Rog.	$\frac{11}{52}$ w. $\frac{20}{92}$, $\frac{18}{52}$ w. $\frac{21}{92}$, $\frac{29}{52}$ w. $\frac{22}{92}$, $\frac{19}{52}$ w. $\frac{23}{92}$
	Se.	$\frac{17}{32}$ w. $\frac{23}{92}$, $\frac{17}{32}$ w. $\frac{28}{92}$, $\frac{21}{52}$ w. $\frac{25}{92}$, $\frac{26}{52}$ w. $\frac{26}{92}$
	Sh.	$\frac{18}{92}$, $\frac{27}{132}$, $\frac{11}{32}$ w. $\frac{23}{72}$, $\frac{11}{32}$ w. $\frac{20}{72}$
	T.	$\frac{21}{112}$

the propensity of the movable cylinder of the small instrument for slipping are quite enough to explain the fact. The mean variations of *Rob.*, *Rog.*, *Se.* and *Sh.* closely resembled those of *T.*, both in size and in degree of uniformity. Those of *Be.*, *Bi.*, *C.*, *M.* and *N.* ran higher, and were more irregular. This fact was undoubtedly due to hasty movements in the cases of *Bi.*, *C. and M.*, and to exhaustion in the cases of *Be.* and *N.* *D.*'s mean variations were large and irregular in the beginning, but improved with his manner of moving the cylinder, and *K.*'s also were large at first, but finally approximated to *T.*'s. *P.*'s were suspiciously small, as small with the fluid-mantle as with the standard olfactometer, and indicated the movement-error beyond a doubt.

Results connected by W. ("with") were found on the same day for the same nostril. The values obtained with gray rubber were chosen for illustration because vulcanized rubber was used with three different methods, and those obtained with coumarine were taken because this scent was used with all the thirteen subjects. Both sets are fair samples of the whole mass of results. The series of *Be.* and *D.* with gray rubber, and of *Bi.*, *C.*, *K.*, *M.*, *N.*, *Rob.* and *Sh.* with coumarine, give pretty clear indications of the validity of Weber's law. That of *Se.* with rubber, and those of *D.*, *P.*, *Rog.* and *Sh.* with coumarine, indicate the operation of the law simply by the fact that as a rule the numerators of the fractions with the larger denominators are larger. The series of *Be.* and *T.* with coumarine are too short to prove anything by themselves. A series in which the numerators of the fractions with the larger denominators are persistently smaller than those of the fractions with the smaller denominators or equal to them may be counted as tending to disprove the law.

In the complete set of results—counting the results of one subject with one substance as one series—there are 55 series for solids. Out of these, 15 indicate Weber's law clearly; 14 indicate it faintly; 11 long

TABLE IV.

Approximate Values of $\frac{\triangle r}{r}$ obtained for Pairs of Standard Stimulus-Intensities Sensed under the Same Conditions,—viz:
Subject, Nostril, Substance, and Hour.

$\frac{\triangle r}{r}$	(1) $r=a$	(2) $r=2a$ or $2a+$	(2) $r=a$	(2) $r=a+\langle a$	(1) $r=a$	(1) $r=2a$ or $2a+$	(2) $r=a$	(2) $r=a+\langle a$
A. V.	C.	C.	C.	C.	C.	C.	C.	C.
⟩½ (A)	20	3	14	11	10		7	1
½ (2)	7	7	5	5	35	1	14	4
⅓ (3)	34	13	7	10	35	57	46	32
¼ (4)	9	32	21	7	6	34	17	32
⅕ (5)	3	11	9	12	3	3	3	12
⅙ (6)		5	4	3	5		1	4
⟩⅙ (Z)	1	3	1	13	1		2	5
Total,	74	74	61	61	95	95	90	90
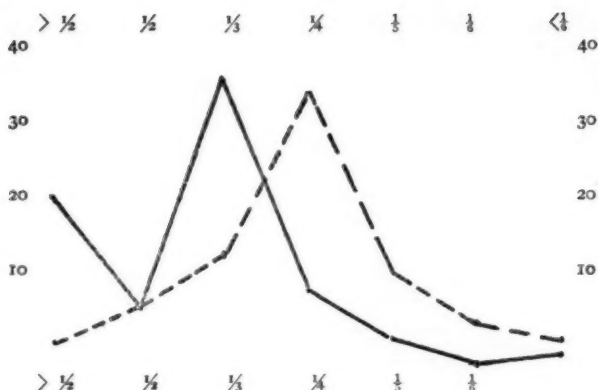
CURVES ILLUSTRATING THE VALUES OF $\frac{\triangle r}{r}$ FOR SOLIDS WHEN $r = a$

AND $2a$ OR $2a+$.   (See Table IV.)

series are of doubtful interpretation ; 13 series are too short to prove
anything ; and 2 tend to disprove the law. Out of 39 series for liquids,
24 indicate the law clearly, and 11 do so faintly, while 3 are too short
to count, and only 1 tends to disprove the law.

We may now proceed to the Tables which summarize the evidence.

As noted before, Table IV enumerates only values for standards
which can be paired as sensed under the same conditions. The left
column of each pair of columns enumerates values obtained for the
smaller standards in the pairs. The columns headed (1) enumerate
values for standards of which one was twice as strong as the other,
or more than twice as strong. The columns headed (2) enumerate
values for standards of which one was less than twice as strong
as the other. All values obtained for standards which can be paired
are included. *A. V.* stands for " Approximate Values," and *C.* for
" Cases."

We believe that we have accounted for the tendency of $\frac{\triangle r}{r}$
to be somewhat smaller for the larger standards. In Table IV,
however, it is clear that the errors to which this tendency is
due do not serve to conceal the operation of Weber's law. If
certain absolute differences of smell-intensity were sensed and
$\frac{\triangle r}{r}$ for a given standard were ⅓, then for a standard twice as
strong it should be ⅙, not ¼.

Tables V and VI are arranged to show such variations as
occur from subject to subject, and substance to substance. That
it may be seen that each subject used a variety of substances,
and that the different subjects used the substances in different
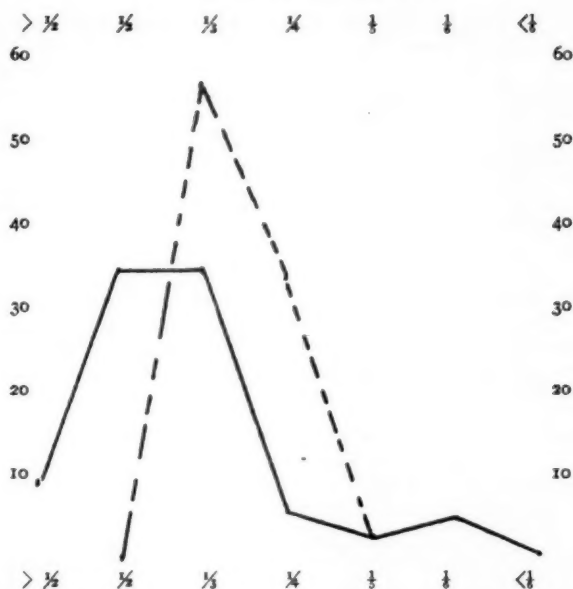
CURVES ILLUSTRATING THE VALUES OF $\dfrac{\triangle r}{r}$ FOR LIQUIDS WHEN $r=a$
AND $2a$ OR $2a+$. (See Table IV.)

Of these curves, the heavy lines give the values for the smaller, and the broken lines for the larger standards. The ordinates give the number of cases, and the abscissæ approximate values.

orders, we preface the Tables with the following list of substances as used in order by each subject :

Be. Black rubber, tolu, cocoa-butter, asafœtida, Russian leather, gray rubber, coumarine, heliotropine, valerianic acid, citral.

Bi. Cocoa-butter, coumarine, vanilline.

C. Gum benzoin, oil of mace, cedar, coumarine.

D. Gray rubber, gum benzoin, oil of mace, coumarine, oil of camphor.

K. Tolu, rose-wood, asafœtida, Russian leather, gum ammoniac and gutta-percha from Utrecht, oil of mace, coumarine, musk, ethyl butyrate.

M. Cocoa-butter, coumarine.

N. Black rubber, tallow, musk-root, rose-wood, oil of mace, heliotropine, oil of camphor, vanilline.

P.　Gum ammoniac and gutta-percha, home-made, glycerine soap, oil of mace, coumarine, oil of camphor.

Rob.　Glycerine soap, gum ammoniac and gutta-percha, home-made, oil of mace, coumarine, vanilline, cedar, gum ammoniac and gutta-percha from Utrecht.

Rog.　Black rubber, paraffine, coumarine, oil of camphor, caryophylline, gum benzoin, oil of anise, laudanum.

Se.　Tolu, rose-wood, tallow, asafœtida, musk-root, gray rubber, oil of mace, coumarine, musk, ethyl butyrate, citral, caryophylline, allyl suphide.

Sh.　Black rubber, cedar, gum ammoniac and gutta-percha, from Utrecht, coumarine, oil of camphor.

T.　Tolu, Russian leather, asafœtida, cedar, coumarine, heliotropine, valerianic acid, citral, pyridin and yellow wax.

The fact that the order was not varied more extensively and more systematically was due to practical difficulties with the apparatus.

TABLE V.　APPROXIMATE VALUES OF $\dfrac{\Delta r}{r}$ ARRANGED TO SHOW VARIATIONS FOR INDIVIDUAL SUBJECTS.

Subject.	Nature of Stimuli	Number of Cases {approximating or equal to}							Total number of cases.
		$\geqq\frac{3}{4}$(A)	$\frac{1}{2}$(2)	$\frac{1}{3}$(3)	$\frac{1}{4}$(4)	$\frac{1}{5}$(5)	$\frac{1}{6}$(6)	$<\frac{1}{8}$(Z)	
Be.	S.	6	9	4	6	3	1		29
	L.	5	5	16	5	5	1	1	38
Bi.	S.				4	4	1	3	12
	L.		1	9	4	1	3	2	20
C.	S.	6	2	7	3	5	1	2	26
	L.		3	6	3				12
D.	S.	9	4	3	6	1			23
	L.		7	6	3				16
K.	S.	3	6	13	5	1			28
	L.	2	6	12	9			1	30
M.	S.						1	2	3
	L.	1	2	4	1				8
N.	S.	4	2	13	13	5	3	8	48
	L.	1	1	10	7	3		2	24
P.	S.			5	4	2	1	2	14
	L.			3	6	4		3	16
Rob.	S.	16	4	10	11	1	2		44
	L.	2	1	8	7	1	1		20
Rog.	S.		1	4	5	5	3		18
	L.		1	21	6	3		1	32
Se.	S.	8	4	11	14	10	3	2	52
	L.	1	19	40	29	3			92
Sh.	S.			2	2	4		4	12
	L.		1	9	3	4		1	18
T.	S.	8	5	11	13	10	2	2	51
	L.	6	11	24	6	1	4		52
Total,		78	95	251	175	76	27	36	738

It will be seen that there is very little variation in the value of $\frac{\triangle r}{r}$ from class to class of substances. All of Zwaardemaker's classes are represented among either the solids or the liquids except Class IX, that of nauseating smells. We could not obtain *Anagyris fœtida* or Indian stink-wood (" Scatolholz ") in the American market, and we did not try soon enough to get it from Europe. Variations in the results of individual subjects are, however, due to variations in the substances used.

TABLE VI.

Approximate Values of $\frac{\triangle r}{r}$ arranged to show Variations for Different Substances.

PART I. SOLIDS.

SUBSTANCE.	Number of cases { equal to or approximating }							Total number of cases.
	$>\frac{1}{2}$(A)	$\frac{1}{2}$(2)	$\frac{1}{3}$(3)	$\frac{1}{4}$(4)	$\frac{1}{5}$(5)	$\frac{1}{6}$(6)	$<\frac{1}{6}$(Z)	
Yellow wax. I,	—	1	3	4				8
Russian leather. I,	2	4	3	5	6	1		21
Oil of mace. II,	25	11	10	4				50
Cocoa-butter. II (?),		3	2	5	5	3	5	23
Rosewood. II,	1		10	10	2	1		24
Cedar. II,			9	2	3		4	18
Tolu balsam. III,			2	8	6	2	2	20
Gum benzoin. III,	6	2	8	6	5	2	1	30
Musk-root. IV,		1	6	7	2	1	3	20
Black rubber. V,		1	4	5	6	4	6	26
Gray rubber. V,		2	4	10	5		1	22
Asafœtida. V,	14	6	5					25
Gum ammoniac and gutta-percha.								
(1) Weaker cylinder fr. Utrecht,	1	3	4	3	2		1	14
(2) Stronger cylinder fr. Utrecht,	1	1	5	7	1	1		16
(3) Home-made cylinder,	10	2	1		1		1	15
Paraffine. VII,				3	3	2		8
Mutton-tallow. VII,			5	3	4			12
Glycerine soap,			2	4		1	1	8
Total,	60	37	83	86	51	18	25	360
Values for oil of mace, asafœtida, and home-made cylinder of gum ammoniac and gutta-percha,	49	19	16	4	1		1	90
Final result,	11	18	67	82	50	18	24	270

TABLE VI.—*Continued.*

Approximate Values of $\dfrac{\triangle r}{r}$ arranged to show Variations for Different Substances.

PART II.   LIQUIDS.

SUBSTANCE.	Number of cases { equal to or approximating }							Total number of cases.
	>½(A)	½(2)	⅓(3)	¼(4)	⅕(5)	⅙(6)	<⅛(Z)	
Oil of camphor. II,	1	7	26	8	6		4	52
Caryophylline. II,	1	2	10	5	2			20
Oil of anise. II,			6	1	1			8
Valerianic acid. II,	10	7	12	2				31
Ethyl butyrate. II,	2	12	8	6				28
Citral. II,		8	26	9	1			44
Vanilline. III,			10	7	1	4	2	24
Coumarine. III,	3	11	34	31	7		3	89
Heliotropine. III,	1	4	14	3	6	1	1	30
Musk. IV,		2	15	6	1			24
Allyl sulphide. V,		5	3	8				16
Pyridin. VI,			2	2		4		8
Laudanum. VIII,			2	1			1	4
Total,	18	58	168	89	25	9	11	378

PART III.   SOLIDS AND LIQUIDS.

Nature of Stimulus.	Number of cases { equal to or approximating }							Total number of cases.
	>½(A)	½(2)	⅓(3)	¼(4)	⅕(5)	⅙(6)	<⅛(Z)	
Solid,	11	18	67	82	50	18	24	270
Liquid,	18	58	168	89	25	9	11	378
Total,	29	76	235	171	75	27	35	648

Almost all the values for solids in which $\dfrac{\triangle r}{r}$ exceeds ½ were obtained with asafœtida, oil of mace, or the home-made cylinder of gutta-percha and gum ammoniac. Thus, out of 9 values in which *D.* exceeded ½ for solids, 7 were found with oil of mace, and out of 16 values in which *Rob.* exceeded ½, 10 were found with the home-made cylinder of gutta-percha and gum ammoniac, and 4 with oil of mace. We believe that it is perfectly fair to exclude these cylinders from our final results. And if we do so there is little variation from substance to substance. The odor of asafœtida and oil of mace was very perceptible when the instrument was closed, and the mace would
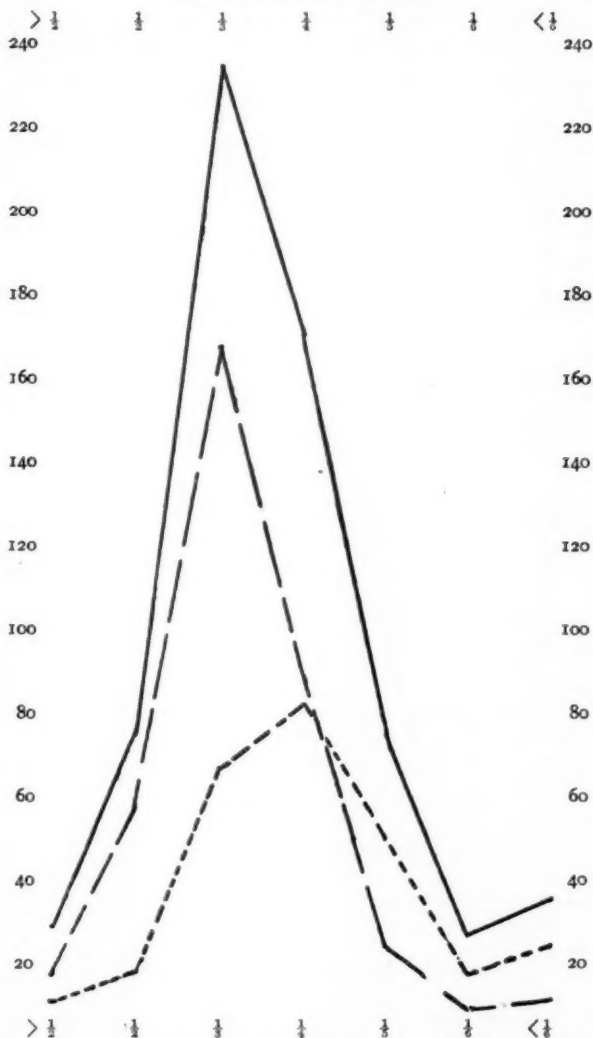
CURVES SHOWING THE APPROXIMATE VALUES OF $\frac{\Delta r}{r}$ IN THE WHOLE COURSE OF EXPERIMENTS BY THE METHOD OF JUST NOTICEABLE DIFFERENCES. (See Table VI, Part 3.)

The heavy line gives the values for both solids and liquids; the dotted line gives the values for solids, and the broken line for liquids. The ordinates give the number of cases, and the abscissæ approximate values.

scrape off on the inhaling-tube.   While Zwaardemaker's mixture of gum ammoniac and gutta-percha is black and brittle like licorice, ours was yellowish gray, contained strings of gutta-percha, and made the inhaling-tube cloudy and sticky. We did succeed in obtaining stimulus-limina with it when the inhaling-tube was first cleaned, but we believe that the end of the tube was probably soiled most of the time during difference-determinations.   We have not excluded the results for Russian leather because its odor, like that of most of the liquids, was just liminal when the instrument was closed, and the results harmonized with the others. Since most of the liquids had this error of the equal but unmeasured increment, it is not surprising that the values of $\frac{\triangle r}{r}$ run higher for them than for solids.   It will be noticed that they run highest for valerianic acid, which was particularly troublesome in escaping from the instrument.   Yet as the results for coumarine, heliotropine, and musk show ⅓ as the most common value, we must conclude *that the value of* $\frac{\triangle r}{r}$ *lies somewhere between* ⅓ *and* ¼.

Some of the substances showed an interesting difference of quality with difference of intensity.   Thus several subjects thought that oil of camphor smelt like nutmeg when weak, and like turpentine when strong.   The slight odor of the paraffine appeared when a strong stimulus was given with coumarine. *T.* said that heliotropine smelled like heliotrope on the left (the better) side of her nose, and like bitter-almonds on the right.   (As a matter of fact the two smells are closely allied.) *Se.* said that the tallow smelled like onions in his poorer nostril.   Fluctuations at the limen were also noted.   Coumarine and heliotropine, when weak, were said to come "in whiffs" or "waves," and *K.* always spoke of weak smells as "scattered."

Section 3.   Results of Other Methods.

Table VII gives some of the results obtained by the method of just noticeable differences modified in the direction of the method of minimal changes, as described in Chapter I, Section 4, and shows the agreement of these results with those reached by the ordinary method. *C. M.* stands for "Combination Method."

We used red rubber with the true method of minimal changes because Zwaardemaker had done so.   The cylinder was obtained from Utrecht.   The experiments of which the results are given in Table VIII extended through five laboratory-hours.   It is needless to say that the instrument was manipulated entirely by the experimenter.

TABLE VII.
Results of the Modified Form of the Method of Just Noticeable Differences.

SUBJECT.	SUB-STANCE.	METHOD AND Standard	NOSTRIL.	No. values Averaged.	$\triangle ro'$	$\triangle ro''$	$\triangle ru''$	$\triangle ru'$	$\triangle ro$	$\triangle ru$	$\triangle r$	$\dfrac{\triangle r}{r}$
D.	Gray rubber,	{ C. M. / $r=19$ }	R.	4	9	8	6	10	9	8	8½	2
			L.		11	8	3	7	10	5	7½	3
		{ C. M. / $r=39$ }	R.	4	18	9	3	11	14	7	10½	4
			L.		18	9	4	8	14	6	10	4
		{ J N D / $r=19$ }	R.	4					2	6	4	5
			L.						7	6	6½	3
		{ J N D / $r=39$ }	R.	4					12	10	11	4
			L.						9	10	9½	4
K.	Rose-wood,	{ C. M. / $r=22$ }	R.	3	15	5	2	11	10	7	8½	3
			L.		11	6	3	16	9	10	9½	2
		{ C. M. / $r=42$ }	R.	4	14	4	5	8	9	7	8	5
			L.		12	6	9	14	9	12	10½	4
		{ C. M. / $r=22$ }	R.	2	10	5	7	10	8	8	8½	3
			L.		8	7	8	4	8	6	7	3
		{ C. M. / $r=42$ }	R.	2	10	6	3	9	8	6	7	6
			L.		11	6	4	10	9	7	8	5
		{ J N D / $r=22$ }	R.						9	9	9	3
			L.						13	15	14	A
		{ J N D / $r=42$ }	R.						8	16	12	4
			L.						7	14	10½	4

TABLE VIII.
Results obtained for Red Rubber by the True Method of Minimal Changes.

SUBJECT—SH.

$r=20$ mm.			Gradation $=2$ mm.		
$\triangle_r^{\wedge}=40$ mm.			$\triangle_r^{V}=4$ mm.		

	r_1 given before r.			r given before r_1.		
	$\triangle ro'$	$\triangle ro''$	$\triangle ro$	$\triangle ro'$	$\triangle ro''$	$\triangle ro$
R. N.	6	6	6	12	6	9
L. N.	6	10	8	6	8	7
	$\triangle ru'$	$\triangle ru''$	$\triangle ru$	$\triangle ru'$	$\triangle ru''$	$\triangle ru$
R. N.	12	6	9	6	12	9
L. N.	8	4	6	8	12	10

	$\triangle r$	$\dfrac{\triangle r}{r}$	$\triangle r$	$\dfrac{\triangle r}{r}$
R. N.	7½	$\frac{18}{40}=\frac{1}{3}+$	9	$\frac{14}{40}=\frac{1}{3}-$
L. N.	7	$\frac{14}{40}=\frac{1}{3}+$	8½	$\frac{17}{40}=\frac{1}{3}+$

Final result: R. N. $\triangle r=8\frac{1}{4}$ mm. $\dfrac{\triangle r}{r}=\frac{33}{40}=\frac{1}{3}+$

L. N. $\triangle r=7\frac{3}{4}$ mm. $\dfrac{\triangle r}{r}=\frac{31}{40}=\frac{1}{3}+$

Zwaardemaker concluded that for a standard of from 2 to 5 cm., the difference limen was about 1.5 cm., and that for a standard of from 5 to 9 cm., it was about 3.5 cm.   This would make the value of $\dfrac{\triangle r}{r}$ run from about ⅓ to about ¾.   Our own results agree fairly well with his, and are a very pretty confirmation of the results obtained by the method of just noticeable differences.   The writer intends to use the method of minimal changes much farther.

In contrast with these excellent results are those of the next Table :

TABLE IX.
Results obtained by the Method of Right and Wrong Cases.

SUBJECTS—C., D., K., N., ROB., ROG., AND T.

Instrument—Standard Olfactometer.   Substances—*Black Rubber or Tolu Balsam.*

r AND r_1.	RIGHT CASES.	WRONG CASES.	MISTAKES MADE IN TAKING THE SECOND STIMULUS FOR WEAKER WHEN STRONGER.	TOTAL NUMBER OF CASES.
20 and 25	37	19	12	56
50 and 70	30	10	9	40
20 and 30	47	19	12	66
30 and 50	33	11	5	44
20 and 40	42	22	18	64
30 and 60	4	2		6
20 and 50	39	11	8	50
20 and 60	7	1	1	8

The stimuli given were never equal, and the judgment "equal" was counted a mistake.   The results of all the subjects are massed.

As we said before, while exhaustion makes the errors nearly all run in one direction, confusion due to the unfamiliarity of olfactometric work is probably most at fault.   More experiments should be made with the standard olfactometer and trained subjects.   It is difficult to use the large olfactometer with this method, because the intervals between stimuli must be made very long or the subject can guess from the time spent in manipulation how they have been changed.

As a rough method of testing the applicability of the method of right and wrong cases to smell, we blind-folded one subject, stopped his ears with absorbent cotton, and required him to tell which way we had moved from a given standard on the large olfactometer.   The results are given in the following Table :

TABLE X.

Results of a Rough Attempt to Gauge the Applicability of the Method of Right and Wrong Cases to Smell.

SUBJECT—K. SUBSTANCE—ETHYL BUTYRATE

Change.	Correct judgments of direction.	Incorrect judgments of direction.	Failures to note change or to distinguish its direction.	Total number of cases.	Change.	Correct judgments of direction.	Incorrect judgments of direction.	Failures to note change or to distinguish its direction.	Total number of cases.
Mm.					Mm.				
20 to 30	95	46	11	152	40 to 60	100	35	6	141
20 to 10	115	27	6	148	60 to 40	106	29	5	140

We see that here again the number of mistakes was very large. Yet these were the last experiments made with *K.*, who had worked for us twice a week throughout the year, and who had used butyric ether successfully in experiments by the method of just noticeable differences. He was, however, very tired at the time these last experiments were made. The second stimulus still is more often mistakenly taken for the weaker than for the stronger, showing that in these experiments also exhaustion outweighed adhesion and the time-error put together. (The tube was cleaned after every eight comparisons.)

SUMMARY AND CONCLUSION.

In beginning our investigations, we saw that we could not isolate simple olfactory qualities, and that an attempt to prove Weber's law for smell was justified only by the assumption that it might apply to fusions. We also saw that the fact that some olfactory qualities show but few grades of intensity pointed to a rise towards the terminal intensity by geometrical progression. Although Zwaardemaker explains the fact partly by the supposition that different smells have different difference-limina, we believe that two smells with the same difference-limen may exhaust the human sense-organ with very unequal degrees of rapidity, so that one may reach the terminal intensity much sooner than the other.

Aside from the condition of the sense-organ, the intensity of a smell depends (1) on the amount of odorous surface exposed to the air, (2) on the time that it is exposed, (3) on the condition of the air in regard to temperature, moisture, etc., which controls the rate of evaporation, (4) on the diffusion-rate of the

vapor, and (5) on the rate and manner of the subject's breathing. The great incidental difficulties in olfactometric work are (1) the variability of the organ through obstruction by mucus or (2) exhaustion, (3) the adhesion of the odorous matter to parts of the apparatus, and (4) the presence of compensating smells. The freedom of the nasal passages may be tested, but exhaustion can neither be prevented nor measured, nor can adhesion and the presence of compensating odors be absolutely excluded. We employed Zwaardemaker's olfactometric method in which (1) the measure is the amount of odorous surface exposed, (2) the time of exposure may be disregarded, (3) the diffusion-rate of vapor is under control, and (4) the subject's breathing is supposed to be self-regulating. We did not (5) succeed in regulating the temperature of our laboratory, but its variability was not of primary importance in difference-determinations. Adhesion makes the method of minimal changes impracticable for most substances with Zwaardemaker's method of smell-measurement, and exhaustion contributes to make the method of right and wrong cases very difficult. We therefore used the method of just noticeable differences. This psychophysical method involves an error from the subject's tendency to judge in terms of hand-movement. Another occasional source of error, incidental to our apparatus, was the escape of some odors between the inhaling-tube and cylinder. Both of these circumstances tend to make the values of $\dfrac{\triangle r}{r}$

smaller for the larger standards. Adhesion and the ordinary time-error tend to balance exhaustion. In spite of the four most serious sources of error, (1) exhaustion, (2) adhesion, (3) the movement-error, and (4) the unmeasured increment to some stimuli, we found $\dfrac{\triangle r}{r}$ to be about ⅓ in 36% and about

¼ in 26% of our determinations. It was about ½ in 12%, about ⅕ in 12%, about ⅙ in 4%, greater than ½ in 5% and less than ⅙ in 5% of the determinations. The slight use we made of the other gradation-methods confirms the general result. There is no great variation from one substance to another, or from one of Zwaardemaker's classes to another.

There is much yet to be done and said in olfactometric work —"of making of books there might be no end"—but we believe that enough has been said and done to offer some evidence that Weber's law applies to smell and that the value of $\dfrac{\triangle r}{r}$ lies between one-third and one-fourth.

MINOR STUDIES FROM THE PSYCHOLOGICAL LABORATORY OF CORNELL UNIVERSITY.

COMMUNICATED BY E. B. TITCHENER.

XVII. CUTANEOUS PERCEPTION OF FORM.

BY D. R. MAJOR, PH. D.

The object of the following experiments was the determination of the limen of form at various parts of the cutaneous surface. Although the investigation is not yet concluded, it seems worth while to publish the results so far gained: especially as there is no literature upon the subject (*cf.* Henri, *Raumw. d. Tastsinnes*, 1898, p. 53).

The forms employed were angles, open circles, filled circles and filled triangles. The *angles* (of 35°) were made by fastening strips of sheet rubber to wooden handles. The lengths of side used were 3 to 10 mm., inclusive. The *open circles* were cut from glass tubing (thickness of glass about .5 mm.), the cut edge of which was ground. The outside diameters ranged between 2 and 11 mm. The *filled circles* were made from solid glass rods, in the same way: diameters 2 to 12 mm. The *triangles* (equilateral) were cut from hard rubber blocks, and fastened to wooden handles: sides 2 to 9 mm. In each series the increment of difference was 1 mm. The method employed was that of just noticeable stimuli, as described by Kuelpe (*Outlines of Psych.*, pp. 55 f.). The subject closed his eyes, and the form was pressed firmly down upon the skin, at the place selected. As soon as the subject had cognised (or definitely failed to cognise) a form, he opened his eyes, and drew upon paper a figure which corresponded to the cutaneous perception. The judgment of cutaneous form was thus recorded in terms of a visual translation. This procedure recommended itself in view of the fact that movement was above all things to be avoided; we were investigating the cutaneous, not the tactual appreciation of form. It may be said at once, however, that one of the subjects (G), who is of the tactual type and has small power of visualization, could hardly be restrained from movement (wrinkling the skin, shifting the fingers, etc.,) in spite of all cautions. With the other two subjects no such difficulty was found.

The subjects — Dr. I. M. Bentley (B), Dr. E. A. Gamble (G), and Dr. W. Manahan (M) — were all trained in psychological methods, and knew in a general way the object of the present enquiry. The procedure with knowledge was, of course, followed in experimentation. *B* soon became aware that only four forms were being employed; *G* and *M* showed no trace of any positive opinion on the matter. The surfaces tested were the tip of the tongue, the tip of the middle finger of the right hand, and the central portions of the red areas of upper and lower lips. It was a mistake to work upon all four with the same forms in a single investigation, since information gained from the points of greater discrimination is almost inevitably transferred to other points, whose limina are thus unduly lowered. The results proved that the dimensions taken were not small enough, in the following cases: angles, on the tongue and under lip; open circles, on the tongue; filled triangles, on the tongue. (The results from *G*, where they stand alone, throw no light on this question, for the reason given above.) On the other hand, the dimensions were too small to allow of liminal determinations on forehead, cheek, ball of thumb, and volar side of wrist. No other surfaces were tried.

Results. The following Tables show the results for the three subjects on the four surfaces. Under *L* is given the average form limen; under *m. v.* the average departure of the single determinations from *L;* under *no.* the number of single determinations made. It must be remembered that a single determination implies the performance of experiments in two directions, ascending and descending; so that, *e. g.*, 10 *L's* required 20 series of experiments. The *m. v.'s* of the partial limina were very small; hence neither they nor the limina themselves are shown in the Tables. The thick figures indicate that the limit of the instrument was reached, or, in other words, that the recorded *L* may be too large.

TABLE I.

Tip of tongue. Unit 1 mm.

Subject.	Λ[1]			O			●			▲[1]		
	L.	M. V.	NO.	L.	M. V.	NO.	L.	M. V.	NO.	L.	M. V.	NO.
B	5	1	8	**2**	–	4	6	`1.3`	3	**3**	.5	10
G	**3**	–	10	**2**	–	4	4	1	5	**2**	–	8
M	**3**	–	10	**2**	–	4	4	1	4	**2**	–	8

[1]On tongue and lips these figures were placed always with the apex pointing upwards or downwards upon the longitudinal axis of the body. Variation of direction made no difference in judgment. On

TABLE II.
Tip of finger. Unit 1 mm.

Subject.	Λ			O			●			▲		
	L.	M. V.	NO.	L.	M. V.	NO.	L.	M. V.	NO.	L.	M. V.	NO.
B	4	.7	11	3	.3	3	5	1	3	4	1	4
G	5	.8	10	2	—		4	.7	4	4	1.1	7
M	5	1.3	6	4	1	3	6	1.3	3	5	2.3	6

TABLE III.
Upper lip. Unit 1 mm.

Subject.	Λ			O			●			▲		
	L.	M. V.	NO.	L.	M. V.	NO.	L.	M. V.	NO.	L.	M. V.	NO.
B	5	.6	8	3	.5	4	6	2	5	6	2	11
G	4	.4	8	2	—	3	5	1.2	4	5	1.3	9
M	4	.6	9	3	.7	4	6	1.5	4	5	.7	6

TABLE IV.
Lower lip. Unit 1 mm.

Subject.	Λ			O			●			▲		
	L.	M. V.	NO.	L.	M. V.	NO.	L.	M. V.	NO.	L.	M. V.	NO.
B	4	1	5	3	.2	4	6	1.5	3	7	2.1	7
G	3	—	9	2	—	3	5	1.5	4	4	1	6
M	3	—	6	3	.3	3	6	1.7	4	7	2	5

It appears from these Tables that, within the limits of our experiments, *the surfaces tested rank*, as regards capacity of form cognition, in the order: *tip of tongue, tip of finger, lips.* (Between upper and lower lip there is no appreciable difference.) It appears further, that the cutaneous surfaces differ in their behavior according as the stimuli are surfaces or outlines: thus the lips are at a disadvantage when the filled circle and the triangle are applied. A different selection of stimuli might therefore lead to a different order of rank. The fact is brought out in Table V, which is obtained by massing the results from the three subjects.

the finger tip, all four possible positions were employed. Unfortunately, we have no separate records for the longitudinal and transverse directions. The introspective notes, however, show (for all three subjects) that cognition was subjectively a little easier when the forms lay transversely upon the surface.

TABLE V.
Limina of form in mm.

PLACE.	Λ	O	●	▲
Tongue . . .	**3.7**	**2**	4.7	**2.3**
Finger	4.7	**3**	5	4.3
Upper lip . .	4.3	**2.7**	5.7	5.3
Lower lip . .	**3.3**	**2.7**	5.7	6
Av.	4	2.6	5.3	4.5

We see from these figures that the *form most easily cognised* by the four surfaces *is the open circle.* It is, perhaps, hardly safe to draw any general conclusion from them as to the order of cognition of the remaining three forms. We may remark, however, that the filled circle was as unsatisfactory as the open circle was satisfactory to work with. This accounts for the smaller number of series given for these two forms in the Tables.

Practice — in some cases extending over a month — was given with each instrument for each place upon the skin. Its effect was twofold. Practice at a given spot increased the subject's power of discrimination (or rather cognition) of form at that spot.[1] And practice at a spot of finer discrimination was, as we have said above, of influence upon the cognition of form at spots of coarser discrimination. The latter fact is clear from our introspective records, especially from those of *B*. There can be no doubt that the influence was enhanced by the character of the method employed, *i. e.*, by the requirement of translation from haptics into optics.

It need hardly be said that the value of a limen is never an absolute value. Limina will vary as the conditions of experimentation vary. Our subjects had all had general practice, and worked according to a procedure with knowledge. While we have reason to think that the limina of these three subjects would have been practically the same if obtained by a procedure without knowledge, experiments (not yet completed) upon subjects lacking in general practice promise to give a higher limen, particularly by a procedure without knowledge. They indicate, too, that the values will differ with the admission or rejection of visualization.

Subliminal judgments. The following Tables show the

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[1] The values given by Titchener (*Outline of Psychology*, p. 164)— triangle, 3.5 mm. on tongue, 7 mm. on finger-tip — are massed values taken from our three subjects at what proved to be about halfway through the stage of practice. On the theory of practice see Henri, *Raumw. d. Tastsinnes*, pp. 27 ff.; Tawney, *Phil. Stud.*, xiii, 163 ff.

nature of the subliminal judgments of form passed by the three subjects. They tell their own tale of individual tendency.

TABLE VI.

Subliminal judgments. Tip of tongue.

SUBJECT.	$\wedge$	●	▲
B	∩	Blur.	● or blur.
G	∧ [1]	Blur.	
M	● [1]	Blur.	

TABLE VII.

Subliminal judgments. Tip of finger.

Subject.	$\wedge$	●	▲	O
B	O or ∩	Blur.	●	Blur.
G	— or ∧	O	— or $\wedge$	
M	— or ∧	Blur.	$\wedge$	Blur.

TABLE VIII.

Subliminal judgments. Upper lip.

Subject.	$\wedge$	●	▲	O
B	∩ or Blur.	Blur.	Blur.	Blur.
G	— or ∧	Blur.	— or O	
M	∩	—	● or ◣	Blur.

TABLE IX.

Subliminal judgments. Lower lip.

Subject.	$\wedge$		▲	O
B	∩ or Blur.	Blur.	Blur.	Blur.
G	— or ∧ [2]	O	— or $\wedge$ or ∧	
M	● or ∩ [2]	Blur.	● or ∩	Blur.

[1] In practice experiments.
[2] In practice experiments.

PSYCHOLOGICAL LITERATURE.

The Origin and Growth of the Moral Instinct, by ALEXANDER SUTH-
ERLAND. London: Longmans, Green & Co., 1898. 2 vols., pp. 797.

The volumes are well printed—an excellence of no small moment to
the much taxed modern eye. Other superficial excellences are: A
comprehensive table of contents, an ample index, and a preliminary
chapter outlining the scope and method of work.

In the preface the author makes special acknowledgment of in-
debtedness to Darwin and Adam Smith. To the former he owes the
general direction of his ethical thinking and, more particularly his
method of investigation and demonstration. "Full half of the book
is a detailed expansion of the fourth and fifth chapters of his *Descent
of Man*." "His (Darwin's) progress in these chapters reminds us of
the march of some active and brilliant general who outlines a great
conquest, but leaves behind him many a fort, and city, and strong
place, to be subsequently beleaguered by plodding officers, each con-
cluding in his own province, by time and labor, what his commander
had effectively done in design." To the latter he owes the more defi-
nite direction of his thesis. "Adam Smith would in all likelihood have
revealed the origin of our moral instincts, had he only possessed a
mere suspicion of that greatest of biologic truths which Darwin was
subsequently to establish. He saw that morality was founded on
sympathy, but nowise perceiving whence that sympathy could possi-
bly be derived, the whole remained involved as much in mystery as
ever."

The author thus states his thesis: "It is the purpose of this book
to show, how from the needs of animal life as they rose and developed,
there sprang, at first with inexpressible slowness, but imperceptibly
quickening as it advanced, that moral instinct which, with its con-
comitant intelligence, forms the noblest feature as yet visible on this
ancient earth of ours." He waives all the "grander and deeper"
philosophic considerations that encompass his enquiry, and devotes
himself solely to tracing "the growth of our moral instincts from their
humble source among the lower animals, with absolutely unbroken
continuity through lowliest savage to the noblest of men, always as a
biologic process."

The book presents three stages of treatment. In the earlier chap-
ters the growth of sympathy is traced. Parental care is adduced as
the condition of the "emergence, the survival, and subsequent ascend-
ency of the more intelligent types." The second stage of the argu-
ment shows how sympathy having "thus entered on its first humblest
existence," has deepened and expanded, giving rise to "the moral
instinct, with all its accompanying accessories, the sense of duty, the
feeling of self-respect, the enthusiasm of both the tender and manly
ideal of ethic beauty." Finally, there is the exposition of a theory of
the physiological basis of those emotional susceptibilities which we
collectively call by the name of "sympathy." (This theory coincides

very nearly with the "visceral theory" of Prof. James, but was formulated in ignorance of Prof. James's work.)

The thesis is supported by a wealth of detailed evidence drawn from the widely varying fields of zoölogy, physiology, anthropology, history, jurisprudence and philosophy.

As a scientific history of "the growth of our moral instinct" this book has two elements of weakness. In the first place, it is an apology and not strictly a history. Adam Smith's doctrine of "morality founded on sympathy" is assumed as a proposition to be demonstrated. Under such conditions an impartial investigation of the facts of moral evolution would be well nigh a superhuman task. In the second place the author's evident disregard of psychology is a grave defect. You scan the index in vain for a citation from a "simon pure" psychologist. This disregard is especially exasperating in view of the author's use of such indefinite psychological terms as "instinct" without even a provisional definition. His treatment, too, of sympathy is somewhat invertebrate. It is defined as "that general tendency which makes men grieve at the pains and rejoice in the pleasures of their fellows," . . . . the capacity of contagiousness in emotion." The physiological conditions of sympathy are set forth with admirable and convincing thoroughness; but the psychological conditions, which can hardly be of less significance in the history of the progressive development of sympathy, are not mentioned. As a matter of fact, the history of the origin and growth of the moral instinct is essentially a chapter in the history of psychogenesis. In the hands of one not a psychologist the subject is bound to suffer.

More specific points of criticism are the failure to take account of the sex factor in the origin of sympathy, which seems to be ascribed wholly to parental instinct; and the practical ignoring of the heredity problem. The author seems to hold to the Darwinian doctrine of transmission. Weissmann is not mentioned.

On the whole this book adds little to clear thinking along the line of moral evolution; but on the other hand it has not a little of moral dynamic in itself. Its purpose is dogmatic, but the controversial temper is generally absent; and a kind of noble idealism permeates all the pages.   W. S. S.

Animal Intelligence: An Experimental Study of the Associative Processes in Animals, by E. L. THORNDIKE. Monograph Supplement, No. 8, of the Psychological Review.

This monograph of 109 pages presents the results of a series of experiments conducted for two years on dogs, cats and chicks, with a view to ascertain the time required and mode in forming their mental associations, together with a determination of their delicacy, number and permanency.

The method used was to confine the animals in enclosures from which they could escape by some simple act, such as pulling at a loop of cord, pressing a lever, or stepping on a platform. The animals, as far as possible, were kept in a uniform state of hunger. This, together with the desire for freedom and discomfort in confinement, were the factors played upon throughout.

He found that the creatures could not learn to do any act from being put through it, "and that no association leading to an act could be formed unless there was included in the association an impulse of the animal's own. Learning, whether among domestic animals or their keepers, is a process in which the learner must shoulder the great bulk of the task.

The interpretations that will probably provoke discussion and

adverse criticism are the following: 1st, that animals, excepting primates, cannot and do not learn the simplest acts from seeing their fellows do them; 2nd, "that the elements in the associative processes are sense-impressions, plus a past 'impulse and act,' rather than between two sense-impressions, one past, and one present." He would argue, if I interpret him aright, that in order for the product of the associative processes to be advantageous to increase intelligence, one of the elements must be an impulse from the motor side as opposed to the idea which maintains that the associative elements in animal psychosis may be between sensations or even between memory images of an elaborate order. For those of us who have an abiding interest and faith in comparative psychology as an important auxiliary to the study of mind, the chief value of the paper lies in its testing a simple method whereby more of the facts of animal psychosis may be set forth.   L. W. KLINE.

A Primer of Psychology, by EDWARD BRADFORD TITCHENER. The Macmillan Co., N. Y., 1898. Price, $1.

A good elementary text-book is by no means easy to write; it is a most searching test both of the real condition of the science for which it is written and of the degree in which the writer has mastered his subject. To write up "results" for Archives or technical journals is one thing, to distil off the vital essence of a science for beginners is quite another. Such a book ought not to be a mere description of the "wonders" of the science in question, still less an abstract account of its theory; it must show the theory alive and luminous in phenomena actually present.

The peculiar merit of Prof. Titchener's primer is the successful attempt to do just this. The general treatment is not only concrete and sufficiently untechnical, but each of the fifteen chapters is followed by a section of "Questions and Exercises," intended to lead the student not only to the better comprehension of the text, but also to an intelligent observation of his own mental experiences. When practicable these observations are given an experimental form, and an appendix is devoted to a convenient list of apparatus and materials, with names and addresses of makers, and prices.

The book, however, covers a much wider field than that of laboratory psychology. After introductory chapters on the nature and methods of the science, the topics of sensation, feeling, and attention are taken up in that order, to be followed by those of perception, idea and association, emotion, simpler forms of action; then memory and imagination, thought and self-consciousness, sentiment, and complex forms of action; the work is concluded by a chapter on abnormal psychology, and another on animal and child psychology and the relation of psychology to ethics, logic and pedagogy. As will be seen from this list, the order of treatment is somewhat peculiar. In the reviewer's opinion it is not altogether happy,—certain logical and systematic advantages having been gained at the expense of a natural pedagogical approach.[1]

The present state of psychological science is apparent in the varying interest of the chapters, those upon matters little touched as yet by the newer methods being painfully skeletonesque. For this, of course, the author cannot be held responsible. It is to be regretted, however, that he did not give more explicit attention to mental

[1] It is perhaps fair to say that the plan is simpler than the chapter headings would suggest, being the usual threefold division treated successively at different levels of complexity: 1, Sensation, Feeling, Attention; 2, Perception (with idea and association), Emotion, Simple Action; 3, Higher Intellect, Sentiment, Complex Action.

hygiene based upon psychological principles, especially as the book is intended for normal and high school students. A few minor inaccuracies also and inadvertencies of expression might well receive attention in another edition; *e. g.*, on p. 33 it seems to be implied that imagination is dependent on changes of blood supply, on pp. 44-45 in considering giddiness the otolith organs are mentioned, but the semicircular canals are not, and on p. 50 the intensity of moonlight is taken much too high. The book is valuable enough, however, to carry off many more than these deficiencies, and will, no doubt, prove extremely helpful even to many above the level for which it was first designed. E. C. S.

The Influence of High Arterial Pressures Upon the Blood-Flow Through the Brain. W. H. HOWELL. American Journal of Physiology, I. (1898), 57-70.

The physiology of the cerebral circulation is a difficult and obscure matter, and has been made even more difficult of comprehension by the supposition that, because the brain itself is practically incompressible and encased in an inextensible skull, any enlargement of the arteries under increased blood pressure must bring about a corresponding compression of the veins, which would hinder the outflow of the blood, and, in case of a sudden and great rise of arterial pressure, might produce anæmia by preventing it altogether. Recent experiments by several observers, however, have made clear that this reasoning was somewhere at fault, for when the arterial pressure in living animals has been made very high by the administration of drugs, the outflow has not been diminished. Prof. Howell has carried these experiments further, and, it would seem, entirely closed the question by showing in the case of dogs previously killed, that even very great pressures (*e. g.*, 500 mm. of mercury, or about 9.7 lbs. per square inch) do not cause any decrease of the outflow from the cerebral veins; in other words that "the circulation in the brain behaves in this respect precisely as it does in the other organs of the body; the greater the arterial pressure the more abundant is the flow of blood." The arterial enlargement is indeed compensated by compression of the veins (and they even show a pulse, due, apparently, to the increase of compression at each arterial pulse) but their total bore is considerably greater than that of the arteries, so that they are never seriously occluded, while the large sinuses, which might suffer more, are protected by tough dural sheaths. E. C. S.

On the Relation Between the External Stimulus Applied to a Nerve and the Resulting Nerve Impulse as Measured by the Action Current. C. W. GREENE. American Journal of Physiology, I. (1898), 104-116.

Experiments were made on the excised nerves of frogs, terrapin, cats and dogs. The curves for the relation of the stimulating current and current of action, plotted from the results, show three stages: The first rising sharply from the abscissa and practically straight, the third also straight and nearly parallel to the abscissa, and the second, a curve with its concavity toward the abscissa, connecting the other two. The first stage extends from the smallest stimuli awakening any response up to the intensity required to bring out maximal muscular contractions and considerably beyond; it is the expression of an arithmetical ratio, each increase in stimulus bringing out a proportional and decided increase in the current of action. The third also represents an arithmetical ratio, but the increase for each unit of stimulus, while still proportional, is quite small. In the nerves of

dogs the author finds, as Waller found for the nerves of frogs, that the first straight portion of the curve is preceded by a short curved portion, convex toward the abscissa. The point of interest for psycho-physics lies in the fact that, so far as inference from these experiments is justifiable, the relation of stimulus and sensation generalized by Weber's law (which many have considered a matter of neural physiology) lies in the activity of some other portion than the nerve fibre.   E. C. S.

The Functions of the Ear and the Lateral Line in Fishes. FRED-ERIC S. LEE. American Journal of Physiology, I. (1898), 128-144.

As a basis for discussing the relation of the ear and the organs of the lateral line Dr. Lee summarizes the results of his admirable studies on the equilibration sense and the ear, already published, together with others not as yet published in detail. The ear of fishes performs both dynamical and statical functions. The dynamical are : First, recognition of rotations (mediated by the semicircular canals and their nervous mechanisms), and second, recognitions of movements of translation (mediated by the otolith organs of the utriculus, sacculus and lagena). The statical function, recognition of position in space (gravity sense), is also mediated by the otolith organs. An ear might seem to imply hearing, but this is not the case in fishes,— Lee's experiments, like those of Bateson and Kreidl, showing these creatures to be without hearing in the ordinary sense of the word, though sensitive to jars.[1]

Lee has also experimented on the lateral line organs in dog-fish, toad-fish and butter-fish with results that point strongly to an equilibrative function as that of these organs also, which agrees with the morphological derivation of the ear from a specialized group of these line organs.

What has probably been the evolutionary history of the developed ear of higher forms is thus sketched by the author : " The primitive function, not improbably, was the appreciation of movements of the water against the body and movements of the body in the water, combined with appreciation of contact, and, hence indirectly and crudely, of position in space; by the exercise of this function, through functional connection with the locomotor mechanism, the equilibrium of the body was maintained. In some unknown way a bit of this sensory system became cut off from the rest and enclosed within the skull ; it still retained its power of appreciating bodily movements and contact, and this power became refined and differentiated; the capacity of appreciating rotary movements was separated from that dealing with progressive movements and position in space, and the two were associated with distinct organs, the semicircular canals on the one hand, and the otolith organs on the other, which were appropriately constructed to subserve their respective functions. Thus, a well-marked sensory organ for equilibrium was evolved in fishes. When aquatic animals began to leave the water and live a shorter or longer time upon the land, and the possible advantage of a sense of hearing was presented, a portion of this sensory organ of movement became still farther differentiated ; a new patch of sensory nerve-terminations

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[1] Lee summarizes one of Kreidl's studies as follows: "In a subsequent paper Kreidl explodes the oft-repeated tale of hearing by fishes that come for their food at the sound of a bell, by investigating carefully the action of trout at the famous old Benedictine monastery in Krems, Austria. He proved that the fishes come because they see the man who brings the food, and appreciate the vibrations of the water caused by his step and communicated through the stone basin; and that, when these are excluded, the sounds of the bell have no effect."

appeared, the papilla acustica basilaris; apparatus for conveying the waves in the air directly to the membranous ear was developed; and thus the power of appreciating the movements we call sound was acquired." E. C. S.

I limiti del pudore nell'uomo e nella donna. Pio VIAZZI. Riv. mens. di Psich. forense, Antrop. crim., ecc. (Napoli), Vol. I (1898), pp. 164-175.

In this article, Viazzi, the author of a work on "Sexual Criminals," in which he sustained in detail the view that woman has a greater sense of shame than man, abandons that opinion, returning to the conviction of Sergi, that by reason of her less amorous sensibility, woman has necessarily less sense of shame than man, though she *seems* to evince and to display more. Woman's use of shame as a means of seduction,—shame in the sense of hiding or avoiding what would excite repugnance or disgust and endanger her amorous conquests; the graver consequences for her of the *coïtus* and the social consequences of unchastity and infidelity, which cause not a little calculation to enter into her sense of shame, until ultimately it departs from the sphere of feeling and enters the region of deliberate reasoning as to consequences of lack of shame; the greater interest woman has over man in showing herself modest and shamefaced—all this lessens the amount of real shame-sense to be attributed to the female sex. A great deal of her apparent shame is merely the clever psychical counterfeit. The pallid frigidity of woman on certain occasions, may be the shadow of shame, but only the ghostly shade. Man's wider range of sexual reactions (shown also in the pathological side of love and its fetishisms) carries with it a greater bulk of shame. Low-necked dresses and exposed breasts still wait their anologues in the drawing room and the theater from men. Women are led to be shameless more easily than men, and shameless in public. For evolutionary reasons, a deeply-felt sense of shame, an organic sense of it are naturally stronger in the sex, whose ego is best protected and defended. A. F. C.

Il dolore nell' educazione. L. M. BILLIA. Nuovo Risorgimento, Vol. VIII (1898), pp. 187-193.

The question whether man is free or not seems to be settled by the answer to the question: Can he inflict pain upon himself for a certain end? Not every pain, or all pain is educative, but without pain there can be no greatness, no virtue, no true happiness, no work, no science, no education. Study is pain, thought is pain, pain is virtue.

A. F. C.

The Origin of the Family. H. SOLOTAROFF. American Anthropologist, Vol. XI (1898), pp. 229-242.

The primary form of the family, according to M. Solotaroff, is "the mother free to contract or dissolve sexual bonds—and the group of children resulting from these sexual relations." The assertion of man's bio-psychic activities and individualities, and the growth, with the vicissitudes of environments of the need of sexual favors, help and protection for herself and her children "have led the woman slowly out of bondage of economic care for her family group, but led her into marital bondage, while the most powerful tendency toward socialization among primitive men, expressing itself in various ways, has incidentally expressed itself, also, in occasional sexual permiscuity as the outcome of the ecstacies of play—one of the most potent instincts of the social sentiment." In his general views the author approaches Westermarck, rejecting the theory of primitive promiscuities. A. F. C.

Piratical Acculturation. W. J. McGee. *Ibid.*, pp. 243-249.

The four stages or phases of acculturation are sketched by Professor McGee, as follows: " The *first* phase is characteristic of savagery; it is expressed in the imitation of weapons and symbols, with the esoteric purpose of invoking new deities; it may be styled *martial* acculturation.   The *second* phase is characteristic of barbarism, though arising earlier and perishing later; it is expressed in semi-antagonistic mating between tribes, with the initial esoteric purpose of strengthening tribal pantheons; it may be called *marital* accultura-tion. . . . . The *third* phase is characteristic of civilization, though it begins in barbarism and plays a role in enlightenment; it is expressed in interchange of goods with the purpose (at first esoteric and afterwards exoteric) of personal profit or gain; it may be designa-ted *commercial* acculturation.   The *fourth* phase is characteristic of enlightenment, though its beginnings may be found much lower; it is expressed in the spontaneous interchange of ideas for the purpose of increasing human power over nature; it may, provisionally, be styled *educational* acculturation." The first two phases are essentially piratical, the last two essentially amicable.   A. F. C.

The Factors of Heredity and Environment in Man. D. G. Brin-ton. *Ibid.*, pp. 271-277.

After pointing out the divergence of scientific opinion upon the sub-ject (Lombroso says " *milieu* can annihilate all ethnic traits," while Collignon holds to hereditary transmission of anatomical peculiari-ties," together with " a difference of brain, revealed by a special direction of the thoughts and the display of special mental powers "), Dr. Brinton emphasizes the fact that " the progress of man is his progress of gaining independence from nature, of making her forces his slaves, and not leaving them his masters "—hence " the depend-ence of man on his environment is not a fixed quantity," for " in the most favored spots to-day it is reduced almost to a zero, so far as its influence on man's higher, soul-life is concerned." Besides there are two psychical elements, temperament and character, which " are largely independent both of heredity and environment." Tempera-ment, Manouvrier calls " the determining cause of the intellectual and moral traits of the individual," and character is " the essential personal element in humanity." It is neither inherited nor acquired, and " it probably begins with the very inception of the individual life;" while " in its essential traits it forever bides the same, resisting all external agencies;" it is that " which in the last analysis [as Wundt demonstrates] prompts the decisions, guides the actions, and carves the destiny of men and nations." The theories of atavism are weaker to-day than yesterday, and the advances in the study of cellular pathology have won whole territories for variation and the heredity of acquired characteristics. The peculiar traits of races may be pathological, the result of that perfect adaptation to one environ-ment which brings in its train unfitness for any other. " Blood will tell," it is true, but just as much temperament and character.

A. F. C.

Familientypus und Familienähnlichkeiten. Graf Theodor Zichy. Correspbl. d. deutschen anthrop. Ges. (München), 1898, (Vol. XXIX), S. 41-44; 51-54.

An interesting study of the features of the Hapsburgs and the Bourbons. The author concludes : 1. Nearly everybody has the features of some near ancestor, but the whole series is necessary for perfect orientation. 2. An inherited family type is not infrequent,

but by no means the rule. 3. Between children of the same parents resemblances are frequent, but mostly only during youth. 4. The resemblances between parents and children are most noticeable in the youth of both. 5. Here and there very striking resemblances to very remote ancestors occur. A. F. C.

L'imitation dans l'Art. FÉLIX REGNAULT. Rev. Sci., 4e série, Tome X (1898), pp. 335-336.

Art has all along its history been prone rather to imitation than to invention—the former is easier. Relics of imitation and repetition are to be found in the symmetries of classic art and architecture.

Studien zur deutschen Weidmannssprache. PAUL LEMBKE. Ztschr. f. den deutschen Unterr., XII. Jahrg. (1898), S. 233-277.

A valuable discussion of the vocabulary of the German "hunter's dialect," with appropriate consideration of such words (*hetzen, Luder, naseweis, unbändig, Wildfang, Hundejunge, Hundsbube, wittern, stöbern,* etc.) and phrases (*durch die Lappen gehen, auf den Strich gehen,* etc.) which have passed into the literary language of the day, the student-language or other clannish forms of speech among the various social classes. It is interesting to note the influence of the "hunt" in a Mecklenburg dialect, where, *e. g.,* the carouse after the hunt is called *Najagd;* a dance is *Klapperjagd;* distinguished people are *Hochwild; de lütt Iagd* ("little hunt") = when a player has many small trump cards; of an old maid they say *ut de jagdboren Johren is se rut* ("she's past her hunting time"). Many hunting proverbs are also noted. A. F. C.

L'Éducation Rationnelle de la Volonté, DR. PAUL ÉMILE LÉVY. Paris, Félix Alcan, 1898. pp. 231.

The thesis of this work is contained in the first sentence of the opening chapter. "We propose to show that it is possible to preserve our moral and physical being from many affections, and if any evil comes to one or the other to draw from our own nature relief or cure." The book is divided into two parts. (1), theoretical; (2), practical. The fundamental psychological law upon which the theory of autosuggestion is based is the fact that every thought is the beginning of action. The will acts more effectually when it acts unconsciously, or without effort, that is as a result of suggestion. Suggestion is of two kinds: suggestion from without, and autosuggestion; but there is no essential difference between these.

Many ailments of the body as well as of the mind are habits. Moral hygiene consists in the fixation in the organism of healthy physical and mental habits.

In the second part of the book many cases are given in detail of the cure by autosuggestion of emotional troubles, of habits, of functional disorders of circulation and digestion. While, according to Dr. Lévy, psychotherapy does not claim to be all there is of therapy, there are cases in which nothing can take its place, there are other cases in which it acts better than any other curative agent. And in all cases it is useful. G. E. PARTRIDGE.

Moderne Nervosität und ihre Vererbung, von CH. FÉRÉ. Arzt am Bicêtre. Durch Dr. Hubert Schnitzer, Berlin.

The book is chiefly a discussion of heredity as affected by nervous diseases. Féré asserts himself a follower of Darwin and an opponent of the Weismann theory of the continuity of the germ substance. His

position is that the conditions of life affect the individual organism, and exert an important modifying influence on the protoplasm.

The influence of heredity is far from being limited to psychic diseases. It extends also to the most organic and functional diseases of the nervous system, and, further, every nervous disease is connected with an anatomical change.

Interesting chapters dealing with degeneracy and hereditary asymmetry are given.

The book is especially valuable as a guide to the literature of the subject, a very large list of authors being cited.

The translator has done his work well. The lucid style of the French author is well maintained throughout in the translation.

NORMAN TRIPLETT.

Le Subconscient chez les Artistes, les Savants et les Écrivains, par le DOCTEUR CHABANEIX, médecin de la marine. Preface de M. le Docteur Regis. Paris, 1897. pp. 124.

In this preface Dr. Regis defines the "*Subconscient*" as the peculiar state between sleeping and waking; between the conscious and the unconscious.

It is this state that Dr. Chabaneix has studied in the cases of a number of authors, artists and scientists. Noting the frequency among such men of somnambulism, neuropathy, hallucinations, etc., the author was desirous of determining whether they were particularly subject to "subconscious" dreams, and if so, what part the subconscious played in their works. He gives the experience of Mozart, Goethe, Heine, Voltaire, Schopenhauer, Wagner, Tolstoi, and many other equally famous men, both historic and contemporary.

He shows that the subconscious appears with great frequency among men of talent and genius, and in the case of many it figures in their productions to a remarkable degree.

Dr. Regis says the study brings to light one of the psychologic conditions under which the great works of the human mind are produced. It establishes also that the personality of men of talent and genius so diversely interpreted, is more often due to nervous erethism than to mental derangement, and that the great creators are often lost in their subconscious abstraction.

The work contains a bibliography of some seventy titles; also a table of the authors cited.

The Use of Color in the Verse of the English Romantic Poets, by ALICE EDWARDS PRATT. Chicago: The University of Chicago Press, 1898. pp. 118.

This work is a thesis for the doctor's degree in the Department of English of Chicago University. The author presents an exhaustive study of the use of color by the seventeen principal English poets from Langland to Keats. The study includes the entire product of each poet considered, except Thomson; and the results have been catalogued and classified. The classification is made in two ways: According to color groups; and according to distribution among fields of interest. The tables and charts give a graphic representation of the subject. The work furnishes some suggestive material for the psychologist. W. S. S.

Leitfaden der physiologischen Psychologie in 15 Vorlesungen. Von TH. ZIEHEN. 4te Aufl. Jena, G. Fischer, 1898. pp. 5, 263.

Professor Ziehen's *Leitfaden*, published in 1891, is well known to American students of psychology in the translation of Messrs. Beyer and Van Liew (2d ed., 1895). It is with this, in the absence of the 3d

German edition, that the reviewer must compare the present volume. The following are some of the more important changes : Lecture II, " Sensation, Association, Action," has new paragraphs on the development of the brain in the vertebrate series ; Lecture III, " Stimulus, Sensation," a new derivation of Fechner's measurement-formula, and modifications in the discussion of Weber's law ; Lecture IV, "Taste, Smell, Cutaneous Sensations and Sensations of Movement," a paragraph on the static sense and the alimentary organic sensations ; Lecture V, "Sensations of Hearing," remarks on the timbre of vowels ; Lecture VI, " Sight " (the whole lecture has been revised, with the assistance of Professor Koenig), paragraphs on visual perceptions of movement and on certain optical illusions ; Lecture VII, " Temporal Attributes and Affective Tone of Sensations," added remarks on afterimages, references to the time-sense, and changes in matter and arrangement throughout the second half of the lecture ; Lectures IX and X, minor additions in the discussion of emotion and of association of ideas ; Lecture XI, paragraphs on the activity experience in attention, and on the relation of attention to intensity of sensation ; Lecture XIV, new matter in the paragraphs dealing with the development of action and with simple reaction experiments ; Lecture XV, consideration of objections to the associative theory of will. The new indices, of subjects and authors, are most welcome, as are the numerous citations of recent literature in the foot notes.

It is plain, from this summary, that the fourth German is a great improvement upon the second English edition of the *Leitfaden*. It is regrettable that Professor Ziehen has seen fit to retain the polemical treatment of Wundt's apperception theory in text and preface. He has, apparently, never understood that theory ; though a reading of the *Grundriss* and *Vorlesungen*, in their recent issues, would be amply sufficient to show him that he has misrepresented Wundt's doctrine.   E. B. T.

Yetta Ségal, by H. J. ROLLIN. New York, G. W. Dillingham & Co., 1898. pp. 174.

Yetta Ségal is a novel, the aim of which is to familiarize the public with the idea of race-mixture as the final step in the mental and physical development of mankind. In the course of the story an American Jewess marries a man who is part American, part negro, and part Spaniard ; and a Japanese woman, one of whose grandparents was European, finds a husband who is half English and half Swede.

With the merits of the story as story we are not here concerned. There can, however, be no doubt of the psychological importance of the fact upon which the author—apart from his references to the Antilles and citations of Herbert Spencer—lays stress : the fact that, in a civilized community, " positive assurance is now impossible as to the racial purity of any individual."

L'Enseignement Intégral," ALEXIS BERTRAND, Professeur de Philosophie à l'Université de Lyon. Félix Alcan, Paris, 1898.

" Unified instruction " is really, according to the author, instruction in all the human sciences for every human being. This book is another and strong appeal for reform in the lack of popular education. Whatever secondary education exists, is not well suited to all classes. There is an aristocracy of learning, whereas there should be perfect equality. No provision is made for the instruction of the sons and daughters of mechanics, laborers and farmers, and these, the mass of the people, are as capable as any of profiting thereby. The great gap comes between the ages of thirteen and twenty.

Descartes and Comte, as national philosophers, are taken as guides

in support of the new movement; for the proposed system is partly in
operation in Lyon and other cities. In the author's outline for popu-
lar secondary education Comte is roughly followed, and according to
this philosopher there are three periods in positive education. The
first is purely physical and under the mother's direction. The second,
between the ages of seven and fourteen, is æsthetic; the study of
the arts and languages. The third is scientific, conforming closely to
the "hierarchy of the seven fundamental sciences." These sciences
are arranged in a logical series; mathematics, astronomy, physics,
chemistry, biology, sociology, and morals. The study of the classics
brings in a bifurcation, fatal to an utilitarian and unified instruction.
The introduction of co-education marks probably the greatest innova-
tion in the proposed new system.

This secondary instruction in the sciences would be given in two
schools; the first or institutes, would be evening schools, and the
course would last seven years. The second, the colleges, would differ
from the first only in that the students devote full time to study and
finish in four years. Chapter three gives the details of the author's
unique plans for these schools.   F. D. SHERMAN.

Introduction to Herbartian Principles of Teaching, by CATHARINE I.
    DODD, of Day Training Department, The Owens College, Man-
    chester, 1898. London: Swan, Sonnenschein & Co.; New York:
    The Macmillan Company. pp. 198.

The author of this work has fittingly prefaced it with an introduc-
tory notice by Dr. W. Rein, of Jena. She has undertaken the task of
transplanting the methods and principles of Herbartian pedagogy into
the elementary schools of England. A summary of the general prin-
ciples of education, and the Herbartian doctrine of interest and in-
struction furnish the English readers with the fundamental concep-
tions of education as seen in the writings of Herbart and his followers.
A good description is given of the course of instruction followed in
the culture-epoch schools of Germany. The most interesting feature
of this work is the attempt to adopt these culture-epochs to the needs
of children of the English race. The legends and history of Germany
are changed for those of England. Miss Dodd closes this interesting
work with a brief history of the rise and development of the Herbartian
movement in Germany.

The Nature and Development of Animal Intelligence, by WESLEY
    MILLS, M. A., M. D., D. V. S., F. R. S. C. Macmillan, N. Y.,
    1898. pp. 307.

At last we have these very careful and objective studies that have
appeared in a fragmentary way in many forms and places, put together
into a more or less systematic whole. Part I is occupied with describing
animal intelligence and comparative psychology; Part II deals with
squirrels, with special reference to feigning, and to hibernation. Part
III treats the psychic development of young animals and its physical
conditions, brain growth and its relation to psychic development; and
part IV represents various discussions. The work is of great acumen,
and a very valuable addition to the literature of the subject, but is
handicapped by a title too large for it. The author's strong point
is fidelity and patience of observation and description rather than
generalization or discussion. The book is so diversified that it needs
the admirable index which it has.

Die Masturbation, von Dr. H. ROHLEDER. Berlin, 1898. pp. 319.

This "monograph for physicians and pedagogues" is written in
conformity to the motto that the "diseases of society can be no more

cured than can those of the body without speaking of them openly and freely." The work is elaborate and systematic, discussing literature, definitions, history, forms, diffusion, onanism among animals, etc. The causes are divided as those lying in the body, as laziness, moral weakesss, over liveliness, precocity, bodily defect, etc.; and those out of the body like education at home and in school, faulty dress, food, abnormal fear, unwholesome occupation. The results are specified for nerves, senses, digestion, muscles, respiration, cerebellum, etc., and therapeutics occupy most of the last hundred pages.

Ueber die Sexuellen Ursachen der Neurasthenie u. Angstneurose, von DR. FELIX GATTEL. Berlin, 1898. pp. 68.

The author, a nerve specialist in Berlin, has evidently been profoundly influenced by Kraus, Hecker, and Brener, and Freud's recent brilliant studies on hysteria, and depends on the basis of 100 sexual cases in the clinique of Krafft-Ebing. The general thesis is that the neurosis of onanists always occurs where there is a restraint of the sexual desire, and full neurasthenia can arise only as a result of masturbation.

Arbeit und Rhythmus, by M. K. BÜCHER. Allg. Phil. Hist. Classe Sächs Ges. der Wiss., Bd. 17, No. 5. Leipzig, 1896.

This important and fascinating monograph shows by many illustrations how half civilized people are prone to work rhythmically and even in concert and to sing. Work is thus argued to be the cause of song and poesy, dance and the drama. This conclusion is illustrated by hypothetical stages of development of lyric and epic poety. Rhythm is potent as a means of unifying work and creating voluntary communities of laborers. Machinery has weakened and in many cases threatens the decay of the rhythmic impulse. If it goes, the superstructure of music will also be endangered.

W. V. Her Book and Various Verses, by WILLIAM CANTON. Stone and Kimball, N. Y., 1898. pp. 146.

This very tasteful little book is made up of prose records of very cute doings, and especially sayings of the heroine, *V. G.* The bushes have their hands full of flowers; the buds are the trees' little girls; Jesus is cleverer than we are; did the church people put Jesus on a cross? her new words, fussle, sorefully, ficky, etc., are stated in prose, and the author then lapses into brief versicles describing the incidents poetically.

A Study of a Child, by LOUISE E. HOGAN. Harper's, N. Y., 1898. pp. 220.

This attractively printed and bound book is illustrated by over 500 drawings by the child. There are eight chapters, the first representing the first year of Harold's life, and so on to the eighth. Following the chronological order the author finds it unnecessary to observe any other, and there is no index to aid the reader. The first year notes are particularly fragmentary, and are only seven pages. Many of the notes are interesting and suggestive, and many are very inane. There are almost no attempts to draw conclusions of any sort, but only objective accounts of specific things the child did and said.

The Development of the Child, by NATHAN OPPENHEIM. Macmillan Co., N. Y., 1898. pp. 296.

The author is the attending physician to the children's department of Mt. Sinai Hospital Dispensary in New York city, whose supplementary culture enables him to discuss in an interesting way the

relation of heredity and environment; the place of the primary school and of religion in a child's development; the value of child testimony; the evolution of the juvenile criminal; the bearings of the mode of development as productive of genius or defect, institutional life and the profession of maternity. The book is on a far higher plane than such works of Taylor and Hogan noticed in this number, but is suggestive rather than conclusive, indicating a certain immaturity of view, and frequently a disposition to expatiate in what are almost the commonplaces of the subject. Still it is a book to be heartily commended to parents.

Psychologie de l'Instinct Sexuel, par DR. JOANNY ROUX. Paris, 1899. pp. 96.

This is an admirable little compend of the subject. Starting with a résumé of the leading current conclusions of biology on the subject, the author passes to the discussion of the general theory of fecundation and thence of love. Its merit consists in the author's wide acquaintance with recent scientific literature in the various fields, and in his lucidity and conciseness of statement.

Citizenship and Salvation, or Greek and Jew, by A. H. LLOYD, Ph. D., Assistant Professor of Philosophy, University of Michigan. Little, Brown and Co., Boston, 1897. pp. 142.

In Part I the author describes the death of Socrates and its influence on Greek thought, and then on Roman. In Part II he describes and discusses the death of Christ in Judea and the fall of Rome. Part III is devoted to an account of the resurrection or the Christian state.

The Study of the Child, by A. R. TAYLOR, M. D., President of the State Normal School of Emporia, Kansas. D. Appleton and Co., N. Y., 1898. pp. 215.

This book is Volume XLIII in Dr. Harris's Educational Series, and makes an attempt to study and present the results of the study of children. It claims no originality, but only to fit the reader to enter upon the study of children. It treats the senses, consciousness, apperception, attention, symbolism, sayings, feelings, will, intellect, concepts, self, habit, character, manners and morals, normal and abnormal. It seems to the writer of this note that the title might, with minor modification, just as well have been the study of the adult, or psychology, according to Froebel, Herbart and Harris. The book is abstract, and contains almost nothing genetic and little that is concrete; but is a restatement of stock matter in the general field of mental philosophy with such adjustments as show that from that standpoint child study has a place, and this is something to be grateful for.

Versuch einer Darstellung der Empfindungen, von WALTER PRIZI- BRAM. A. Hölder, Wien, 1898. pp. 28.

This posthumous work, edited by the author's brother, attempts "to bring sensations as immediately given purely psychic facts into a mathematical system, the formulas of which shall be a complete desciption of single sensations in general, and discussable under the special cases." It is impossible to describe the system in brief form. Five large tables present the chief terms and forms used.

Essai sur la Classification des Sciences, par EDMOND GOBLOT. F. Alcan, Paris, 1898. pp. 296.

The first chapter discusses the formal unity of sciences, logical dualism, and the common laws of the development of all sciences, viz.,

induction, mathematics, and deduction in the sciences of nature. The main body of the book is an exposition of the system of sciences which falls into the following order: Arithmetic, algebra, geometry, mechanics, including cinematics and dynamics, cosmology, biology, psychology and sociology, including æsthetics and morals. Other sciences are sub-sections of these.

L'Illusion de Fausse Reconnaissance, by E. BERNARD-LEROY.   Paris, 1898. pp. 249.

The author sent out a long questionnaire to educated people request-ing accounts of striking experience of having been in a new place. Of his returns he selects and prints in full 86, which make the last 150 pages of his book, the first being devoted to discussions.   Reject-ing Ribot's theory that there are two successive and perfectly conscious impressions, the first real and the second hallucinatory, he holds recognition to be a unique kind of "intellectual sentiment" associated with re-known phenomena.   The manifestations of this sentiment may become almost chronic.   It is not necessary to assume a difference between sensation and perception, or between impersonal impressions and those where the subject is conscious.

Classified Reading, by ISABEL LAWRENCE.   Published by the author, St. Cloud, Minn., 1898. pp. 423.

This is a descriptive list of books for school, library and home. Pedagogy, child study, geography, history, English, and miscella-neous, the latter including manual training, drawing, physical culture and music, are the chief topics.   There are wide margins for additional literature.   It is easy to find fault with every such book both for what it includes and excludes, but on the whole this can be most heartily commended to every teacher or student of geography, history or English, as a very valuable companion and helper in their work.

Ignorance, by M. R. P. DORMAN.   London, 1898.   pp. 328.

The author undertakes to study the causes and effects of ignorance in popular thought and to make educational suggestions.   No one before has attempted to reduce ignorance to a science.   Its effect is traced on art, letters, capital, economy, state, woman, and collective and individual ignorance are distinguished.   The author emphasizes unconscious causes and cures.   Large ideas in small minds, the retire-ment of the fittest, new superstitions of ultra idealism, ultra spirit-ualism, uncritical orthodoxy, the substitution of feeling for the ease with which women conceal ignorance by following custom, the degra-dation of the pulpit, press, stage, methods of advertisement, etc., are among the causes of ignorance to be contended against.

The Elements of Physical Education, by D. LEMOX, M. D., and A. STURROCK.   Blackwood, London, 1898.   pp. 241.

This is a teacher's manual copiously illustrated with 147 cuts of children practicing free gymnastics and using ball, wand, dumb-bells; and some 40 pages of new gymnastic music, by H. E. Loseby.   The first 67 pages are taken up with very elementary anatomy and physi-ology.   It is a practical and interesting book.

A Course of Practical Lessons in Hand and Eye Training for Stu-dents, 1-4, by A. W. BEVIS.   London, 1898.

These are four handbooks of some 150 pages each, illustrating a new course of work adopted by the Birmingham English School Board, and are full of new and suggestive work.

The Play of Animals, by KARL GROOS. Tr. by Elizabeth L. Baldwin.
    Appleton & Co., New York, 1898.   pp. 341.

It was a happy idea to translate this valuable book from the Ger-
man, and Miss. Baldwin has done her task very acceptably.   Professor
Baldwin writes a characteristic preface of eleven pages, and a re-
printed appendix of four pages quoting from himself, or referring to
his work some fourteen times, claiming four out of nine factors of
organic evolution, and offering a series of criticism, " even though to a
thinker like Professor Groos they may be trivial and easily answered."
On the whole the work of Groos is commended, but were not most of
its best ideas either hinted at or better expressed, or were not most of
the facts more truly stated by Professor Baldwin at some distinctly
previous date ?

CORRESPONDENCE

Dr. Herman T. Lukens has written the following personal letter to the editor. It was with no thought of publication, but Dr. Lukens has kindly consented to let it appear in the *Journal*, without change :

My Dear Sir :

I have just been out to Chevy Chase to see Dr. Elmer Gates and his laboratory. The work on enlargement of the laboratory is still under way, so that I did not see things and apparatus in working order, but in heaps. He has raised the old building one story, and built a new first story. It is a fine situation on the same lot with his residence, with ground enough around for two or three new buildings besides a fine lawn. The property is his own, laboratory and all, but he has received donations of various amounts (I think he said $320,-000) from Mrs. Phebe Hurst and others to aid in special investigations. His work covers the whole range of the sciences. He has just invented a way of getting an electric current from the action of sunlight without the intervention of dynamo or engine. He started in on the study of looms some time ago, and in nine months had sixty-eight new inventions of improvements in the loom ; one of these inventions he disposed of for ten per cent. royalty, receiving $62,000, with which he is building his new laboratory now. He employs a force of trained assistants, machinists, etc. His metallurgical room is for investigations in alloys. He proposes to make a complete series of 10,000 (or so) varying percentages of alloys of certain two metals, and test the properties of the alloys. He is at present on optics and acoustics. He proposes to put up a building in which will be museum, laboratory and all apparatus needed to demonstrate every known fact about sight or sound. Then he will take a class through by his method of work, which goes by regular stages: (1) Sensations, (2) Images, (3) Concepts, (4) Ideas, (5) Thoughts, 1st order, (6) Thoughts, 2nd order, (7) Thoughts, 3rd order. He aims to get as many different sensations as possible. Out of these come images of objects. These are grouped by likeness into concepts. Then the concepts are each to be related to every other one. He keeps going over and over the material trying to find relation of concepts systematically, *i. e.*, of every possible pair. He lays much stress upon this mechanical completeness of the system. He goes to bed at 8.30 and gets up at 5.30, works till 1 or 2, and gives afternoon to social life and relaxation.

He and his wife began to prepare themselves for parenthood a year or two before they created their last child. They avoided all onesided specialism and aimed to develop all the good emotions and exercise their minds on the whole round of human knowledge. During pregnancy his wife avoided all evil passions, anger, envy, etc., and cultivated good emotions, social and altruistic instincts, art, literature, dramas, the sublime in nature, heavens, the spirit of the cosmos, etc. The child was born at full time, without any pain, and the whole process of birth took only two and one-half hours. He has two bright children, on whom he has been trying various new ideas. The oldest at 21 months, he says, knew 11,000 words.

He is at work on sexual perversion, invisible rays of the spectrum,

conditions of work, etc. He has records for twenty years of his own activity and environment, atmospheric potential, electrical potential, barometer, wind, etc. He has an army of readers working for him in the gigantic task of sifting facts out of scientific books. He is trying to get all the alleged facts collected, and then test these and weed out the theories and mere "accepts," thus reducing the great mass of rubbish to a small compass of accessible facts,—a scientific Bible, as he says; for what is more sacred than truth, and what more satanic than falsehood? He showed me a great mass of manuscript material,— an attempt to work over the Standard Dictionary and extract the words that stand for new ideas in sound and light. These are on catalogue cards for purposes of classification, and filled several large drawers.

He has a great mass of notes that have been collecting for 20 years, and which he proposes to begin to edit in a series of books which will bring out his ideas better than anything else he has thus far done. These will include best regimen for work, scientific rearing of children, method of invention, encyclopædic Bible of science, etc.

Dr. Gates has a lovely home, into which he has put a large part of himself. It shows the man of ideas and of resources. He is affable and cordial, gave me unstintingly of his time and attention, and spoke freely of everything. He seems to me to have made a great mistake in not publishing, so as to get the criticism of fellow workers and the steadying influence of co-operation in investigations. But he is sincere, has the scientific spirit, and is a man of original ideas who will be more and more known as the years go by.

NOTES AND NEWS.

DR. WRESCHNER'S WEIGHT EXPERIMENTS.

In my review of Dr. Wreschner's *Beiträge zu psychophysichen Messungen* (this *Journal*, IX, 591 ff.), I noted the fact that the author nowhere states whether his subjects were informed of the time-order of the experimental series. "Were the subjects told the time-order of the first double series or not? Presumably not, since the procedure at large was procedure without knowledge. . . . The knot is cut if the subjects were acquainted with the time-order in every case ; but this is nowhere stated." (P. 593.)

Dr. Wreschner has requested me to give publicity to the following statement : "The subjects were always told beforehand whether a P I or a P II series was coming. The method was only so far without knowledge that the magnitude of the weight of comparison was unknown to the subjects in each experiment. I regret that I did not expressly say this in the chapter 'Das Versuchsverfahren;' but a remark upon the matter occurs on p. 210 (2 lines from the top)."

I am very glad to call attention to this correction, which is of great importance for any estimate of Dr. Wreschner's theory of the time-error. I may add that the sentence on p. 210 was one of the two or three puzzling passages that led me to note the omission pointed out in my review.   E. B. T.

EXPERIMENTAL PSYCHOLOGY IN ENGLAND.

During the absence of Dr. W. H. Rivers with the Borneo Expedition, the courses in Experimental Psychology at University College, London, are given by Mr. E. T. Dixon, known by his mathematical publications in the *Proceedings* of the Aristotelian Society, and by his work on visual space recently published in *Mind*.

THE WELBY PRIZE.

The Welby Prize of £50, offered for the best essay on the subject of "The Reasons for the Present Obscurity and Confusion in Psychological and Philosophical Terminology, and the Directions in which we may look for Efficient Practical Remedy," has been awarded to Dr. Ferdinand Tönnies, of Hamburg. A translation of the successful essay will shortly appear in *Mind*.

UNIVERSITY NEWS.

Mr. Henry Wilde, F. R. S., of Manchester, has endowed in the University of Oxford a Wilde Readership and a John Locke Scholarship in Mental Philosophy.

Dr. R. Macdougall has been appointed assistant director of the Psychological Laboratory in Harvard University; Dr. F. G. Lancaster, professor of Psychology and Pedagogy at Colorado College ; Dr. C. H. Judd, professor of Experimental and Physiological Psychology in the School of Pedagogy, New York University ; Dr. D. S. Miller, lecturer in Psychology at Columbia University ; Dr. E. Thorndike, instructor in Psychology at the Western Reserve University ; Mr. G. M. Whip-

ple, assistant, and Dr. I. M. Bentley, instructor in Psychology at Cornell University ; Dr. E. A. Gamble, instructor in Psychology, Wellesley College.

In accordance with the request of the Government of Venezuela, and of the Committee on Organization, the III Pan American Medical Congress has been postponed to meet in Caracas in December, 1900.

FORTHCOMING BOOKS.

The following books on psychological subjects are announced as in preparation :

Baillière, Tindall & Cox : " Aids to Psychological Medicine," by T. A. BEADLE ; " Handbook for Attendants on the Insane," by authority of the Medico-Psychological Association.

Cambridge University Press : " An Introduction to Psychology," by G. F. STOUT and J. ADAMS.

J. & A. Churchill : " Clinical Lectures on Mental Diseases " (CLOUSTON), with new plates.

C. Griffin & Co.: " Mental Diseases," by W. B. LEWIS.

Longmans & Co.: " Psychology in the Schoolroom," by T. F. G. DEXTER and A. H. GARLICK.

The Macmillan Co.: " First Experiments in Psychology, an Elementary Manual of Laboratory Practice," by E. B. TITCHENER.

Scientific Press, Ltd.: " Medical Aspects of Education," by P. G. LEWIS ; " Mental Nursing," by W. HARDING.

W. Scott, Ltd.: " Degeneracy," by E. S. TALBOT.

Swan Sonnenschein & Co.: "Aristotle's Psychology," by W. A. HAMMOND ; Wundt's " Physiological Psychology," trs. by E. B. TITCHENER.

University Correspondence College Press : " Manual of Psychology," by G. F. STOUT.

BOOKS RECEIVED.

ALEXANDER, ARCHIBALD. Theories of the Will in the History of Philosophy. Charles Scribner's Sons, N. Y., 1898. Pp. 357. Price, $1.50.

BERNARD-LEROY, EUGENE. L'Illusion de fausse reconnaissance, contribution a l'étude des conditions psychologiques. Félix Alcan, Paris, 1898. Pp. 269. Price, Fcs. 4.

ERDMANN BENNO, und DODGE, RAYMOND. Psychologische Untersuchungen ueber das Lesen auf experimenteller grundlage. Max Niemeyer, Halle (Lenicke & Buechner, N. Y., 1898). Pp. 360. Price, Mk. 12.

HIBBEN, JOHN GRIER. The Problems of Philosophy. An introduction to the study of philosophy. - Charles Scribner's Sons, N. Y., 1898. Pp. 203.

JAMES, WILLIAM. Human Immortality. Two supposed objections to the doctrine. Houghton, Mifflin & Co., Boston and N. Y., 1898. Pp. 70. Price, $1.00.

LENNOX, DAVID, and STURROCK, ALEXANDER. The elements of physical education. A teacher's manual. Wm. Blackwood & Sons, 1898. Pp. 241. Price, 4 shillings.

LOURIE, OSSIP. Pensées de Tolstoi (d'après les textes russes). Félix Alcan, Paris, 1898. Pp. 179. Price, Fcs. 2.50.

NAVILLE, ERNEST. Le libre arbitre. Etude philosophique. Deuxieme edition, revue et corrigée. Félix Alcan, Paris, 1898. Pp. 311. Price, Fcs. 5.

PIAT, M. L'ABBÉ C. Destinée de l'homme. Félix Alcan, Paris, 1898. Pp. 244. Price, Fcs.

THOMAS, P. FELIX. L'éducation des sentiments. Félix Alcan, Paris, 1899. Pp. 287. Price, Fcs. 5.

VERWORN, MAX. Beiträge zur Physiologie des Centralnerveusystems. Gustav Fisher, Jena, 1898. I Teil. Pp. 92. Price, M. 2.50.

RAYMOND, F. et JANET, PIERRE. Névroses et idées fixes, II. (Travaux du laboratoire de psychologie de la clinique a la Salpêtrière. *Deuxieme Série.*) Félix Alcan, Paris, 1898. Pp. 559. Price, Fcs. 14.

CLARK UNIVERSITY.

DEPARTMENT OF PSYCHOLOGY.

The following courses are offered for 1898-9:

DR. G. STANLEY HALL.

1. THE HISTORY OF ANCIENT PHILOSOPHY. Two to four hours a week.
2. SYSTEMATIC PSYCHOLOGY.
3. ABNORMAL PSYCHOLOGY. One hour weekly through the year.
4. PSYCHOLOGICAL SEMINARY. Weekly from 7 to 10 P. M.

DR. E. C. SANFORD.

1. BEGINNER'S COURSE. One hour weekly, throughout the year. First Term: Text-book (Titchener's Primer) with Discussions and Demonstrations. Second Term: Lectures and Demonstrations. DR. SANFORD.
2. ADVANCED COURSE. One hour weekly, throughout the year, with a second hour a week when required. Text-book (Külpe's Outlines), Discussions, Lectures and Demonstrations. DR. SANFORD.
3. PSYCHOLOGICAL PRACTICUM. Four hours weekly, throughout the year. First half year: Laboratory practice work on the senses (Sanford's Course in Psychological Psychology). MR. GODDARD. Second half year: practice work upon higher mental processes, DR. SANFORD; and comparative psychology (observation of animals), MR. KLINE.
4. RESEARCH WORK in Psychology at hours suited to the needs of those engaged in it. DR. SANFORD.

DR. C. H. HODGE.

1. COMPARATIVE STUDY OF NERVOUS SYSTEMS AND SENSE ORGANS. Six lectures during January and February.
2. EMBRYOLOGY AND GROWTH OF THE HUMAN BRAIN AND SENSE ORGANS. Six Lectures with Demonstrations and Literature.
3. PRACTICAL HISTOLOGY OF THE NERVOUS SYSTEM. This is a purely laboratory course.
4. GENERAL LABORATORY WORK, one hour weekly, through the year.

DR. A. F. CHAMBERLAIN.

1. GENERAL ANTHROPOLOGY. One hour weekly throughout the year.
2. SPECIAL COURSE IN ANTHROPOLOGY. One hour weekly, throughout the year.

CORNELL UNIVERSITY.

DEPARTMENT OF PSYCHOLOGY.

The following courses are offered for 1898-9:

1. INTRODUCTION TO PSYCHOLOGY. Lectures and Demonstrations. Three hours weekly. Professor TITCHENER. Fall Term. Text-book: Titchener's Outline of Psychology. (This course is followed by Logic and Ethics in the Winter and Spring Terms.)
2. EXPERIMENTAL PSYCHOLOGY. Laboratory work, with occasional Lectures and Demonstrations. Three hours weekly, throughout the year. Professor TITCHENER, Dr. BENTLEY and Mr. WHIPPLE. Text-books: Wundt's Human and Animal Psychology, Sanford's Laboratory Course, Titchener's Outline of Psychology.
3. READING OF PSYCHOLOGY IN GERMAN: Fechner's *Elemente der Psychophysik*. One hour weekly, throughout the year. Professor TITCHENER.
4. SYSTEMATIC PSYCHOLOGY. Lectures, Essays, and Experimental Demonstrations. Three hours weekly, throughout the year. Professor TITCHENER and Dr. BENTLEY. Books of Reference: Wundt's *Physiologische Psychologie*, Kuelpe's Outlines of Psychology, James's Principles of Psychology, Stout's Analytic Psychology, Sully's The Human Mind.
5. SEMINARY FOR PSYCHOLOGY, AND ADVANCED LABORATORY WORK. In graduate and undergraduate sections. Daily, throughout the year. Professor TITCHENER, Dr. BENTLEY and Mr. WHIPPLE.

Full courses are also offered by the Faculty of the Sage School of Philosophy in History of Philosophy, History and Philosophy of Religion, Logic and Metaphysics, Ethics, and the Science and Art of Education.